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ENGLISH AND AMERICAN RAILWAYS.

PROBABLY no other comparison of the methods of operating railways in this country and in America has the same importance as the report which has just been made by Lieutenant-Colonel H. A. Yorke, R.E., who recently made a tour through the States on behalf of the Board of Trade.

As chief inspector of railways under the department, Colonel Yorke is probably able to take a more comprehensive view of the contrasts exhibited in the methods of the two countries, than any individual member of any of the numerous deputations which have recently crossed the Atlantic, for the purpose of inspecting the methods and appliances of which so much has been heard. By virtue of his varied experience Col. Yorke is naturally in a better position to co-ordinate his observations than are those whose attentions have been more particularly directed to one phase of such work.

The depreciation of all things British and the exaltation and advertisement of all things American has of late been worked for all it is worth; and it is refreshing to hear from an observer of Colonel Yorke's experience that the state of British railways is not so parlous as a somewhat hysterical lay Press would have us believe.

By those who had taken the trouble to study the problems met with in connection with transport on both sides of the Atlantic, the booming of American methods was rated at its true value; but the danger of misapprehension of the real facts lay in the vociferance of the detractors of English methods rather than in the knowledge they displayed or the accuracy of their judgment. Time and again we have been treated to lengthy disquisitions—fluently inaccurate in the main—on the superiority of American methods in track and locomotive construction, the handling of goods, the signalling of lines, and similar matters in connection with railway organisation and operation; but in very few cases have really good reasons been adduced for the preference displayed, and the thoughtful man has seen no more in these expressions than the hand of the advertiser.

Colonel Yorke's report embraces a wide range of subjects, including the question of sizes of locomotives and rolling stock, and the reasons for the differences observable; automatic couplings; application of the air brake to other than passenger trains; allocation of expenditure to capital and revenue accounts; signalling; surface, elevated, tube and shallow lines for large cities; inter-urban lines, and practically all the questions relating to railways around which so much controversy has recently been carried on. Whilst it may not be possible to agree fully in every case with the conclusions presented in, or to be inferred from, the report, it is yet the most masterly exposition that has yet come to hand of the numerous and most important problems confronting railway officials at this moment. These pro-

blems acquire an added importance from the very large amount of capital sunk in existing steam railways. Anything which tends to depreciate the value of such properties will entail enormous loss and hardship. That the present period is a critical one in the history of steam railways is unquestionable, and shareholders are uneasily watching the local inroads made by the electric tram. Any further development of this means of transport, in antagonism to the steam railways, will depreciate the values of such properties to an enormous extent, and may easily give rise to a financial crisis, the end of which cannot be foreseen.

The operation of English railways presents problems of quite a different character from those met with in the States, in consequence of the more limited area to be served, and the comparatively insignificant distances over which traffic has to be hauled. The transport of the commerce of the country is as important as that of the individual, if not more so, and its prompt delivery is now the pressing question for the railways of this country. Any attempt to model the transport of goods or merchandise between towns such as, say, Leeds and Bradford, Manchester and Liverpool or Birmingham, or any of the large towns in the Midlands, on lines suitable for American long-distance traffic would be an example of fatuous folly involving further important delays in delivery which are already bad enough. The view which looks upon the actual cost of haulage as the sole cost, or even the greater part of the cost of transport, is out of perspective. There are innumerable other items of cost, such as collection and delivery, warehousing, transhipment, yard and siding accommodation, non-use of rolling stock to the fullest advantage, &c., all of which more or less directly add enormously to the actual cost of operation. The great bulk of traffic is for short distances only, and the actual cost of haulage under such conditions becomes a mere bagatelle in the total. The salvation of the steam railways of this country is intimately connected with quick delivery of material, and this requires an alteration of methods of transport of a directly opposite character to that which modelling upon American lines would involve.

Colonel Yorke does not appear to be an enthusiastic admirer of the American systems of automatic signalling, and looks upon them as labour-savers only, which add nothing to the safety of operation. This is undoubtedly their true function, and railway signal engineers in the States are perfectly frank on the point. Such systems, moreover, do little to facilitate the traffic, and they involve the use of delicate apparatus for which most careful maintenance is requisite. In some cases, again, they involve alteration or modification of rolling stock, as, for instance, where wheels have wooden centres.

It is claimed for such systems that sections may be made shorter, and more traffic be crowded on the line. But signalling systems do not alone govern the arrangements, and, moreover, the *main lines* of this country are not congested, as any observant traveller may see. That short sections are conducive to ease in operating a large number of trains is unquestionable, but occupation of all sections of a line—which is the ultimate capacity of the line—involves greater uniformity of speeds and braking power than obtains at present. The differences in speeds are at present too great to allow of anything like full use of the main lines in this country. At the same time it is only by such radical changes in the methods of operation as are here indicated that railway companies will save themselves from a competition as ruinous to them as was their competition with previous methods of transport in the early years of last century to those interested in such methods.

On the subject of *personnel*, perhaps more may be derived inferentially than from the direct remarks of the report. Colonel Yorke appears to think that English railway companies would get better service by following the American plan of picking men for their ability, and giving every man subsequent opportunities to rise to higher grades by means of periodical examinations for promotion. "Every man upon an American railway has the road open to him to rise to the highest positions, and many of the most prominent men in the railway world have so risen." This statement, however, must be taken with reserve, as the road is only "open" to the extent of the vacancies. If, however, it be considered as a statement that a man may hope to reach such a position as he may covet by hard work and the necessary qualifications, no exception can be taken; but there are those who consider that the continual test which a man undergoes in the performance of his duties is a far more effective test of ability and conduct than any "examination."

The bases of promotion indicated are, of course, sound. Promotion should in all cases be the result of ability and conduct, and in the earlier years of railway work promotions were undoubtedly made on these bases. Many English railways can also point to prominent men who have risen from the ranks; but class distinctions are rapidly making their way, and the cult of the "public school" or "university" man is becoming more general, and the inevitable result will be that there will be fewer examples of men who have passed from the ranks to positions of importance in the future. Whether this will be to the ultimate benefit of the service is a matter for conjecture.

Municipal Fittings.

We wish all success to the efforts which are being made to secure influential Parliamentary support for the defeat of municipal fittings supply proposals. At the moment the prospects of the opposition being successful are brighter than in previous years when such plans have been brought forward only to fail, but it will not do to trust too much to prospects. The matter must be settled, and that decisively; the trade wants to know, once and for all, what it has to expect. It is but a detail in the great subject of municipal trading, but it is an important one, and affects the interests of some thousands of contracting and installation firms in all parts of the kingdom. There is some satisfaction in believing that private electrical interests are not in immediate peril. This was specifically shown by Mr. Gerald Balfour, in the House of Commons last week, when the appointment of the municipal trading Select Committee was under discussion. The Board of Trade, he mentioned, had hitherto refused to admit into provisional orders provisions to permit municipal authorities to manufacture electrical fittings. We have no doubt that this definition of the Board's attitude was intended to include also the "supply and installation" as well as mere manufacture. This is naturally, one of the points upon which the Board is anxious to have the advice of such a representative committee. We are glad that Mr. John Burns took the line he did in relation to this matter, for the unreasonable remarks of which he made use ought to alienate a good deal of the sympathy that the municipal party might otherwise obtain from those who are halting between two opinions, and only want to be blown on to the right side by a little more extremist vapouring from the municipal socialist. He went so far as to say that "There was no tittle or shadow of a public demand for this inquiry"! And he also said—his reasons, if he has any, are not stated in the *Times* report—that "The body best able to decide whether or not electrical fittings should be made by a municipal authority was the municipality itself." We will not argue the matter, it is hardly worth while, except to agree that municipal enterprise has limitations which have to be drawn to some extent according to local circumstances, but while that is so, local councillors can hardly be allowed to settle the main course to be followed in

what has become a question of national concern. A national tribunal must settle the general lines of policy, and the local authority must carry out its local work on the lines laid down.

Electric Supply Competition.

It must come as a revelation to those who have not very closely studied the electric supply situation in London that electric lighting competition is allowed to play great havoc with existing interests. We do not propose to discuss the City of London and Charing Cross rivalry, for as the accounts for the year 1902 have shown, both companies are doing useful work in an exceptionally fruitful field.

What are more particularly present to our mind are the trials and tribulations of the London Electric Supply Corporation. In spite of unparalleled difficulties — difficulties which would have sent it to the wall irremediably but for the determined support and generous sacrifices of the late Lord Wantage—the company is at last feeling its feet, and after meeting preference and debenture interest is able to place something to reserve. It is true that it has still to pursue a cautious policy if it is to ensure lasting stability and a possible interest for the ordinary shareholder; but the point we wish to specially emphasise is this, that the company has competing with it in the supply of electricity in different parts of its area, nine companies and two municipalities. One of the companies—we have not inquired which—has a monopoly in its own area, and charges 7d. per unit there, but when it climbs over the hedge into the London Electric Supply preserves it charges 4d. 'Twere but common justice, it would appear, to allow the London Electric to itself break through the hedge and set up retaliatory competition on a like basis, but we do not recommend the Corporation to accept such a suggestion, its policy of caution being a better one. It must use all its energies upon its existing areas.

So much for the company competition. But the London Electric Supply Corporation has two municipal rivals as mentioned, and one of these while battling with the Deptford station supply lands its ratepayers in considerable financial losses. And the London Electric Supply Corporation has to help to pay for this loss, incurred by a system which is trying to make its own a failure! Small wonder is it that feelings of indignation possessed the meeting of the Deptford Co. last Friday, and great wonder that Mr. Burns, of Battersea, should think that anyone is going to believe him when he minimises the demand for inquiry. That there is ample reason for an inquiry, and that of a most complete description, who with any knowledge of the subject can honestly deny? We have cited these few points, because we believe that they will serve as indications of the great issues that are at stake.

The Inventor and the Business Man.

Most inventors discover, after they have obtained their patent, that the fortune which they expect to realise is still a long way off. A considerable amount of capital is required to work most inventions, and the difficulty is to find a financier to take it up, or if he does take it up, to pay the inventor a fair price for his invention. To get over this difficulty, Mr. Swinburne recently proposed in *Page's Magazine* to form "a strong financial concern to develop inventions on terms that are fair to both parties." This concern is to be advised by competent specialists on technical and financial questions. The technical experts are to hold shares in the concern. Does Mr. Swinburne propose to present the shares to the technical expert? Otherwise only technical experts who are capitalists need apply. He expects that such a concern would develop enormous industries and make an immense amount of money. In the current number of *Page's Magazine* Mr. de Segundo discusses Mr. Swinburne's scheme, in which he has not much faith. He appears to think that the business man needs protection as much as the inventor, and cites from his own experience some terrib'e examples of swindling patentees. His own solution of the difficulty is a combination of the business man with the consulting engineer or consulting chemist. But surely there is little novelty in this proposal; financiers and *bonâ fide* company promoters, as things are, usually consult both legal and technical experts before embarking their capital in a new venture. We agree with Mr. de Segundo that the most successful and important inventions are made by men who have worked all their lives in the particular trade or manufacture their invention seeks to improve. Inventors of this class usually find the least difficulty in getting their inventions worked. But there are still a considerable number of inventions which strike out new lines, and create new industries, and which cannot, therefore, be taken up by established manufacturers. It would be undoubtedly a considerable gain to the country if there were some institution by which such novel ideas could be thoroughly tested, the good inventions sifted from the worthless, and fairly floated with sufficient capital to make their development a success. As long, however, as our manufacturers fail to recognise the importance of being in the vanguard of technical progress, the new invention will never find the ready market which it finds in such countries as the United States and Germany, where labour-saving appliances are better appreciated.

The Training of Apprentices.

Mr. E. E. Matheson, works manager to Messrs. Andrew Handyside & Co., Ltd., of the Britannia Ironworks, Derby, has written a letter upon the above subject in a recent issue of the *Standard*. Mr. Matheson speaks very highly of technical institutions for training young men, holding that, from a business point of view, the actual value of the education which they impart increases directly as the complexity of design and number of parts contained in the product manufactured in the shops to which the students belong. The more complicated are the articles made, the larger is the proportion of apprentice labour which can be utilised; and if that labour is intelligently trained, loss of time and material is avoided. But the actual value of the training received in technical colleges does not lie so much in the education as in the contact of young impressionable minds with highly-trained "fine characters," who are experts at reaping wisdom and teaching it, and who can take a wide view of the many questions dealt with. The students, in fact, come back to the workshops with greater appreciation for their work, with a wider altitude of thought, which enables them to bring logic and common sense to bear upon their daily operations. So valuable to the employer is the effect of the training in these institutes, that on occasion it might be advisable for large engineering concerns to have special training schools of their own; and always, if possible, the lads should be allowed to take their classes in the morning. Evening classes are not so beneficial, for the students are too tired in body to be able to assimilate instruction without an undue nervous strain. The wages of apprentices should be raised as they pass the examinations of the local institute, thus giving them some interest in their studies. Writing of Derby, Mr. Matheson states that the question of technical education is partly solved, and the local college is so full of apprentices that new classes have had to be started; while in Nottingham several firms have taken up the idea, and have made arrangements for the attendance of their juniors. Mr. Matheson remarks that a barrier of misunderstanding and coldness has grown up between masters and men since the old Guilds disappeared, which has been strengthened by the men's unions and the masters' federations. Labour combinations ought to make the most of their organisations, so as to promote greater intelligence among the younger men; and employers ought to make every use of intellects trained to attack and overcome the increasing number of industrial problems awaiting solution. "There is no doubt at all that Technical Institutions are increasing in value, and will continue to prosper in proportion as an intelligent interest is taken in all that is attempted, and a real effort made to utilise even a fraction of what is offered. The time is coming [come?] for the masters and men to approach and come together through the medium of technical education—the first move being taken by the employer."

SAFETY DEVICES FOR TRAMWAY TROLLEY WIRES.

By DONALD SMEATON MUNRO, A.I.E.E.

Fatalities caused by electric shock are happily rare in this country: yet every engineer knows that almost any overhead trolley tram system is pregnant with destructive and death-dealing possibilities. Public attention is drawn at intervals by scare type in the newspapers, but most people have forgotten the incident before the Board of Trade inquiry is through.

For the better protection against accidents from trolley wires, the Belgium Government prescribes three earthed guard wires for each trolley wire, besides transverse guards where telephone wires run parallel with the tramway lines. These, with maximum cut-outs, are trusted to soothe the fears of the people. But it is evident that this clumsy arrangement cannot be an efficient safeguard against half the dangers presented by dangling, broken, charged wires, whether they be trolley, telephone, telegraph, or even the guard wires themselves.

In most of the cities of the United Kingdom, the efforts made to afford protection are even more feeble. In the United States they are practically absent; there, we are told, accidental contacts save the doctors much trouble and transfer the worry to fire and other insurance men.

The evident danger has prompted many inventors to search for a remedy—too often with imperfect or incomplete results.

There are on the market several mechanical disconnecting switches, designed for mounting overhead—usually on the trolley wire support—and actuated by the changes of tension and position which occur in a trolley wire when it fractures. To be effective, these should be numerous; they are necessarily heavy, and might well cause a series of troubles of their own. Against commonest sources of danger they are no protection at all.

Many engineers rely upon the overload cut-out at the station end of feeders for disconnecting trolley wires from the source of supply, when wires fall on the live trolley wire, or

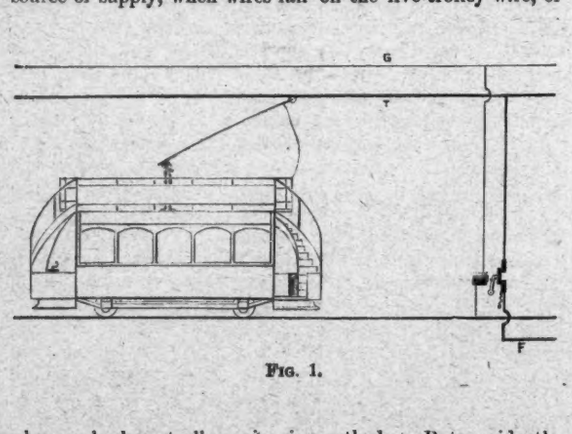


Fig. 1.

when a broken trolley wire is earthed. But, evidently realising its insufficiency, they usually instruct motormen to earth the circuit at the cars, and sometimes to turn off local supply switches also, when anything goes wrong overhead. But even this combination of precautions is too slow and uncertain to give safety, unless favoured by good luck. Dangling telephone wires, even if caught and held by the guard wire as well as by the trolley wire, may be cleared from the guard wire by deflagration as quickly as the cut-out acts; and so the station cut-out and the danger are presently restored. A broken trolley wire may make insufficient "earth," and so not actuate the cut-out at all. The first of a group of telephone wires to fall may set off the cut-out, so that the others dangling in contact with the trolley wire are ready to communicate shocks when the cut-out is put up. A live wire falls on a crowded car or street and makes a more or less inefficient or intermittent "earth:" a maximum cut-out falls in the station, miles away. As the fall of a cut-out is a too frequent occurrence, the attendant, glancing perhaps at a so-called line-clear indicator, slashes in the cut-out, and the process is repeated; or, worse still, the current remains on, all to the extreme discomfiture of the unfortunate individual who may be completing the circuit with his body. Occasionally the motorman may have presence of mind to try to earth the system, only to find that he has gone off the defective section, or is on the idle side of the broken trolley wire. It would be easy to multiply dangerous possibilities, but when engineers have a convenient and safe arrangement offered to them, they will not long continue to subject their plant and cables, unnecessarily, to the terrific stress of a "dead-short."

In Santiago de Chile accidents became so frequent, that a commission of electrical experts was appointed by the municipality to get at the best remedy. They reported, in March, 1901, that, in their opinion, the only really safe method was to bury all the telegraph and telephone cables, or, if that were impracticable, to adopt the device of Prof. A. E. Salazer, who was a member of the Commission. Prof. Salazer made an exhaustive study of the existing protective inventions before he finally devised his arrangement, a description of which appeared in the Electrical Review of September 27th, 1901. It so happened, however, that the same arrangement was patented by the present writer in February, 1901, but, of course, it could not be known to Prof. Salazer, as this patent was not published at the time of his

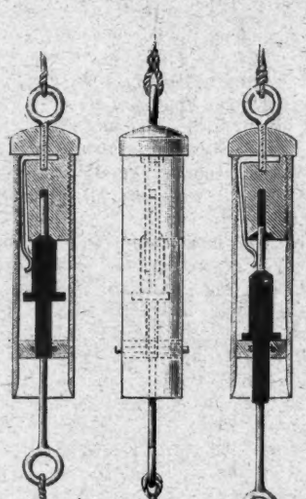


Fig. 2.

report. The nature of this device will be understood from fig. 1. The guard wire is earthed only through the high resistance releasing coil—or a resistance and coil—of a cut-out switch placed on the feeder, in a street box, or at the station if preferred. When the guard and trolley wires are electrically connected either by firm or by light contact, as with a fallen telephone wire for example, a small current passes from the trolley wire along the guard wire to the high resistance coil of the cut-out, releases or actuates its automatic switch there, and so disconnects the feeder branch from the trolley section. Thus, without shock to the electrical system, the trolley wire section becomes dead until the fault is removed and the switch is restored. If the trolley wire section is fed from both ends, both ends are thus cut off, or, where routes do not permit of this, they are by like means disconnected. By this simple and inexpensive method the utmost possible degree of security is afforded against all accidents to trolley wires, except the fall and fracture of the trolley wire itself; for, perhaps, neither the falling trolley wire nor its supporting wires would be springy enough to ensure contact with the standing guard wires under those circumstances. For protection against this rarer accident some would rely upon their overload cut-outs, but to bring this form of trouble also within control of the "guard cut-out" described above, it is only necessary to provide some method of making

sure of an electrical contact able to convey a very small current between the guard and trolley wires when the latter breaks.

Fig. 2 illustrates an appliance* for this purpose. It is more reliable, less clumsy, and less exposed to weather troubles than others which have been suggested. It is about 3 in. long, and is hung between the guard and trolley wires, being joined to each by flexible copper cords, attached for choice at points of support which change their relative positions when the stresses are altered by fracture of one or other.

The well-known device invented by Mr. Quin, late of Blackpool, is on right lines so far as it goes. But has it not these marked disadvantages?—It needs long, special, and well-insulated pilot lines; its overload side still acts with the stress inseparable from an overload switch, and not always needed to secure safety when wires fall across trolley lines. The switch has apparently to be reset every morning, and perhaps oftener, as it goes "off" every time the pressure becomes low, or the line is disconnected. This last objection, which must seriously militate against its adoption, could be obviated by fitting to it certain appliances, one arrangement of which is shown in fig. 3.

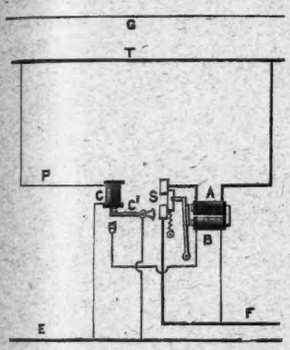


Fig. 3.

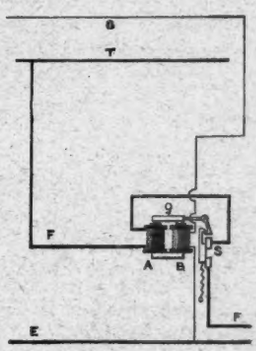


Fig. 4.

It may be well to state here that these sketches are merely diagrammatic, being drawn so for the sake of clearness, that the electrical and other connections may be more easily followed. Parts fulfilling similar functions are, in the several drawings, so far as possible, marked with the same letters. The methods are applicable to other than overhead conductors for tramway traction, but they are here shown as applied to such tramway wires. G is the guard wire; T is the trolley wire. The lines representing these are necessarily short, and the working appliances represented on a much larger scale, but each line marked G or T represents a section of any length—say, 500 yards—and connections made to either end of these short lines are to be taken as made to either end of the section. The switch apparatus may be gathered together in the generating station, or preferably in street boxes situated near the first junction of the feeder cable to the overhead trolley sections concerned. F is the feeder cable from the generating station. E is earth, rails, or return conductors, or the mid wire of a three-wire system as the case requires. R is a resistance. P (used only in a few of the arrangements) is a pilot wire from the far end of the trolley wire. S is any suitable automatic switch, diagrammatically represented here by a pivoted or flexible armature with a detent thereon, which is, by spring or gravity, normally held so as to retain a bridging piece making contact between terminals connected to the trolley and the feeder wires respectively. The bridging piece, when released by the effective attraction of the armature by one or other of its electro-magnets, falls, or is pushed, or pulled, so as to break connection between the feeder and the trolley wires, and leave the overhead section "dead." Alternatively, but not preferably, the armature, when attracted, may put the feeder to earth, and thus melt a fuse or cause an overload cut-out at the station to go "off." In the latter case, the attracted armature, at the option of the engineer-in-charge, may, or may not, lock itself so as to keep the "earth" on until the armature is restored by hand, as a signal to the station that the line is clear. A, B represent two electro-magnet coils. In figs. 3 and 4 either may act as circumstances determine.

(To be continued.)

* This and the other appliances and devices illustrated in this article were patented by the author of this paper in February and in August, 1901.

SOME NOTES ON THE COMMERCIAL MANAGEMENT OF TRAMWAY UNDERTAKINGS.

By C. H. WORDINGHAM.

The second of the two articles under the above title by Mr. Sheffield, referred to in the Jan. 30th issue of the Electrical Review, appears in the February number of *Feilden's Magazine*. It is essentially a series of notes, the author's ideas being presented under a number of disjointed headings.

Mr. Sheffield strongly advocates the use of signalling at dangerous junctions and curves, pointing out that the elaborate precautions insisted on for railway work cannot well be wholly dispensed with on tramways. Signalling is already in use in certain instances, and its necessity was strongly emphasised in a case that recently came under the present writer's notice. A car ran 30 ft. on to a swing bridge through the driver not pulling up in time. Fortunately the bridge was closed, but if it had been open, a fearful accident would have resulted. It was the intention of the authorities to provide signals when the line was laid over the bridge, but they had not been fixed at the time, as the bridge was temporarily the terminus of the route. It would seem that something more than signals would be desirable in a case of this kind, and that, when the signal is at danger, the current should be cut off from a sufficient length of trolley wire to warn the driver in the event of his over-running the signals by the automatic slacking of speed, and to allow of the car being stopped with certainty after the warning was given. If the cars had electric brakes, they would, of course, have to be of the kind operated by current generated by the motors.

The second note deals with automatic points controlled by a switch on the car and operated by a battery fixed at the road-side, thus enabling a man or boy to be dispensed with. Many automatic devices require both a man and a boy to keep them in working order, but these points may be an exception.

Mr. Sheffield is next switched off automatically on to instructions to motor-men, report cards, of which he gives a model blank form, bonus system of payment for drivers according to the energy consumed and, as a necessary corollary, the provision of a watt-hour meter on each car. It is very questionable whether meters on cars, except for experimental purposes, are likely to be satisfactory. They are trouble enough in ordinary central station work, and the jolting of a tramcar must tend to greatly increase the likelihood of trouble from broken jewels, pivots, &c., while the indignant consumer disputing his account would be a lamb compared with the truculent driver who thought the meter had swindled him out of his bonus, as he certainly would if the bonus were not the maximum possible.

A list of further suggestions is given under the title of car regulations. Among these may be mentioned the insulation of hand-rails (greater security would be attained by effectually earthing them), rotary brushes to clean the rails and secure better contact between them and the wheels (it is doubtful if they would effect the purpose), and insulated rollers over the top of the car to protect the outside passengers (a good suggestion).

Attention is called to the danger of removing the trolley at night until the car is clear of passengers. That there is considerable risk in leaving the car in darkness for a minute or so during the time the conductor is fishing for an invisible wire is undoubted, passengers being liable to be hurt in getting out of the car, and also to become the victims of pick-pockets. The best remedy would be to liberally light

the terminus with arc lamps. This would give security to the passengers and help the conductor to catch the wire.

An earthing device is illustrated in which on breaking a pane of glass a ball drops, short-circuiting the trolley line to earth. A few brickbats should be provided to enable the glass to be broken from a safe distance, otherwise the adventurous spirit who does the deed may have his nerves, if not his eyes, permanently injured.

Excellent illustrations are given of the Bellamy covering for the roofs of cars which is to be fitted to 42 of the Liverpool cars. This covering, though closed to the rain, is, we are told, "open to all the world," not being patented, so that a considerable field is anticipated for it.

Lifeguards next claim attention, and that adopted by the Manchester Corporation is illustrated. It consists of a bluntly pointed prow with lattice wirework, having its bottom edge only just out of contact with the ground, this small clearance being rendered possible by supporting the guard from the axle boxes and so avoiding the see-saw motion inevitable if it be attached to the car body. The shape is such as to throw the unfortunate caught by the guard to one side. It seems extremely likely to effect its purpose, and to heave the victim bruised by Scylla, the car, over to the tender mercies of Charybdis, the lorry. Why should not the prow have a pneumatic, or, at all events, a rubber buffer? It would diminish the risk of serious damage by impact with the structure. The provision of lifeguards is certainly desirable, but inventors cannot be expected to effect the impossible, and it surely is against nature to expect any person to stand in front of a car going 8 or 12 miles an hour and to be knocked down by it without being hurt. He must of necessity come off second best, like Stephenson's "coo" with the railway train.

There follow figures covering the number of accidents caused by electric cars, which are most reassuring, and show that the popular idea that electric cars are dangerous to pedestrians is not borne out by facts. At the same time, the safest course is certainly to regard every tram route as a level crossing on a railway and act accordingly; it will help to maintain the reassuring aspect of the figures.

The next note describes a car fitted up for watering and brushing the track and for cleaning the grooves and treads of the rails.

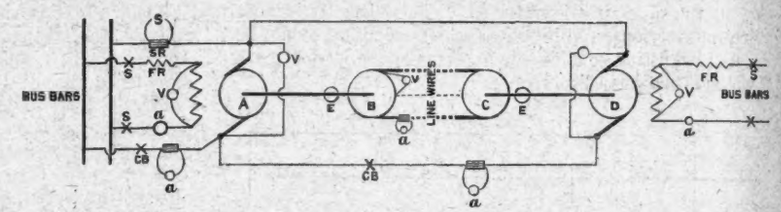
The article concludes with a comparison between tramcars and railways for suburban traffic, to the advantage of the former. Properly managed, the tramcar has undoubtedly much to recommend it, but in those towns in which standing inside the car is allowed, the resultant discomfort is such as to turn the scale in the opposite direction, and the effect of this unwise policy is to cause many who had given up their railway season tickets to revert to them, for few people care to make the morning and evening journey of 20 minutes or half an hour with people clad in wet macintoshes standing on their toes and poking their umbrellas in their faces. Cushions or carpets on the seats also do much to promote a fœtid atmosphere in the cars, as well as to increase to a very unsavoury extent the number of small and voracious passengers carried free, thus further detracting from the merits of the tramcars.

THE TESTING OF ALTERNATORS.

The test room often experiences considerable difficulty in finding some suitable method by which alternators may be tested on full load. Machines of moderate voltage and small output may be safely loaded on rheostats. In the majority of cases, however, rheostats are inadmissible, and less dangerous means must be adopted. The testing of two motor-alternator sets is a case in question. Let one set consist of a 250-kw. 500-volt shunt-wound, direct-current motor driving a 225-kw. 5,000-volt star-connected three-phase alternator of the rotating field type. The other will be an exactly similar alternator driving a 200-kw. 500—550-volt compound-wound generator, the machines being arranged so that the alternators take the place of the shaft in the well-known Hopkinson method of testing generators.

From fig. 1 we see that A, running as a direct-current motor, drives the alternator B, and that alternator C, running in synchronism with B, drives dynamo D, which returns energy to A. The power supplied from an external source to the combination (including excitation) will be equal to the loss in the four machines.

As is well known, there is one particular value for the excitation of a synchronous motor at which the armature current will be a minimum, and therefore practically in phase with the impressed E.M.F. Running the motor on light load, we may obtain a series of values of the armature current for different excitations. From curve A, fig. 2, which was obtained from the alternator C, we note that the excitation corresponding to minimum current was 14·2.



A, 250-kw. D.C. Motor; B, 225-kw. A.C. Generator; C, Synchronous A.C. motor; D, 200-kw. D.C. Generator; a, Ammeter; V, Voltmeter; SR, Starting rheostat; S, Switch; CB, Circuit breaker; FR, Field rheostat; E, Exciter.

Fig. 1.—Diagram of Connections.

It is quite possible to start up a three-phase synchronous motor by opening its field circuit and passing current through the armature. Owing to the high E.M.F. induced in the field, insulated generally for a working E.M.F. of not more than 250 volts, this method is not to be recommended. In this case the machines are to be run up to speed from the direct current sides, and the fields so adjusted as to have the current in phase with the impressed E.M.F. at the motor terminals, and the generator D returning current to the first motor.

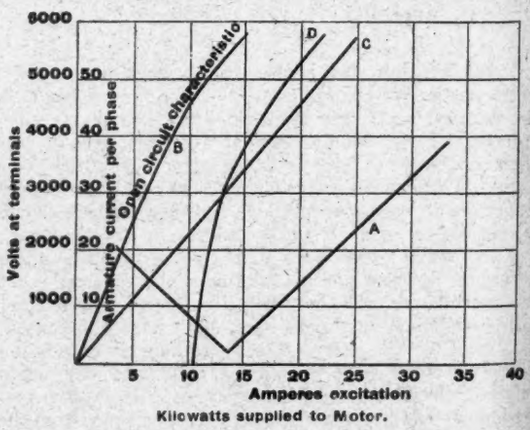


Fig. 2.

After a six-hours' run on full load the temperature rise of the thermometer was as follows:—

Alternator as generator.		Alternator as motor.	
Field	= 25° C.	Field	= 27° C.
Armature winding	= 40° C.	Armature winding	= 36° C.
Armature core...	= 25° C.	Armature core ...	= 32° C.

These temperatures are well within the limits usually expected by engineers with this class of machinery.

Although the only scientific method of measuring the temperature rise of insulated metal is to take the increase of the resistance, it is as well to employ thermometers, for inaccuracies due to defective instruments or errors of observation often occur. In order to determine what values of field excitation are necessary for different loads, so that the terminal pressure shall be constant, it is usual to obtain the open circuit characteristic and the synchronous

impedance curve. The former is obtained by running the machine at normal speed and plotting the terminal pressure against the field current (curve B). The synchronous impedance curve shows the relation between the current per phase in the short-circuited armature, and the value of the field excitation at normal speed; needless to say, the ammeter should have no appreciable resistance or inductance (curve C).

In some cases this curve has an upward bend after a certain value of field excitation has been reached, which shows us that the iron is being worked at a high magnetic density, and consequently armature leakage does not increase proportionally to the armature current. When taking the open-circuit characteristic, the hysteresis loss in the armature is obtained by noting the power supplied to the driving motor, when the alternator is unexcited, and subtracting this power from that required for any particular value of the excitation.

From the curve D, obtained in this manner, we perceive that the hysteresis loss at 5,000 volts is 8 KW.

In order to secure satisfactory inherent regulation, it is necessary that the magnetic circuit be worked at a fairly high saturation; that is to say, the normal voltage of the generator should be well up on the bend of the open circuit characteristic. With a generator working on the straight part of its open circuit characteristic, out-of-phase currents will have a much greater effect on the field, necessitating, in the case of inductive loads, a large increase in the excitation.

When there are no convenient means of loading an alternator, a temperature test may be carried out as near to actual working conditions as possible by reversing the exciting current in a portion of the field, so as to have normal field and full load current through the armature on short circuit. Thus, if it takes *a* amperes of excitation to give normal voltage, and *b* amperes to give full load current on short circuit, we require to reverse the current at such a point in the field that *a* times the difference between the reversed and unreversed bobbins shall be equal to *b* times the whole number of bobbins.

CORRESPONDENCE.

Sparking Plugs for Automobiles.

In your last issue appeared a note under the above heading, stating that Messrs. Panhard & Levassor recently discovered that the interposition of a spark gap external to the cylinder made it possible to ignite even when the sparking points were bridged with a carbon deposit; this method of cleaning the sparking points is a very old dodge with oil engines, and was known at least 11 years ago. At this time it was not generally understood, and was only used on troublesome engines when ignition was very irregular, but on the introduction of the marine oil engine, with explosions both top and bottom of the piston, it came into everyday use; in fact, with certain large engines, it was impossible to do a long passage without resorting to this method of ignition on the bottom of the cylinders; for obvious reasons the cooling water was pumped in at the bottom round the stuffing box and passed upwards, hence the trouble of condensation, carbonising, &c.

On several occasions during 1894 and 1895 I did passages of 500 miles with this method of ignition, and that Messrs. Panhard & Levassor should claim to have discovered it, or Mr. Haycraft the solution of it, is putting it rather strong.

W. McL. Dann.

Newcastle, *March 3rd*, 1903.

[It is unfortunate that our correspondent kept this valuable information to himself so long; he might have netted a considerable sum if he had turned his knowledge to account. Certain it is that the recent discovery, be it re-discovery or not, is of great importance to automobilists.—EDS. ELEC. REV.]

Electro-Metallurgical Problems.

I have noticed in Mr. Alec. Beadle's article on "Electro-Metallurgical Problems" (No. 1,318, February 27th, 1903, of your paper), several remarks which hardly represent the actual state of some of the electro-metallurgical industries touched upon.

To begin with, he refers to the Stassano process, which is still more or less in its experimental stage, as the only one by means of which ferro-chrome and ferro-manganese can be produced. Both of these alloys, as well as ferro-silicon, containing as much as 75 per cent. silicon, are very extensively and regularly produced by half-a-dozen Continental concerns by means of cheap water-power.

With regard to his remarks as to the recovery of tin from tin-scrap being beset with difficulties, this is hardly applicable, as the firm of Th. Goldschmidt, of Essen, Germany, for instance, works up nearly 10,000 tons of tin-scrap per annum, not to mention three or four others. There is not the slightest difficulty in obtaining a coherent and regular deposit of tin from alkaline solutions, provided the right conditions are adhered to.

With regard to tungsten metal, most of this metal is used as such, and comparatively little as ferro-tungsten. The metal is produced in the form of a gray powder (not by electrical means), containing 96 per cent. and upwards of metallic tungsten.

Attempts to produce this metal in an electrical furnace have been unsatisfactory, owing to the strong affinity which it has for carbon. The resulting carbide would be totally unfit for tool-steel makers' use or for similar purposes.

Trusting that some of the above remarks may be of use to experimenters and others interested in this matter,—

Tungsten and Rare Metals Co., Ltd.,
P. J. STEINHART, Ph.D., F.C.S.,
Managing Director.

London, S.E., *March 6th*, 1903.

The Wiring of Buildings.

Referring to "Foreman's" letter in your issue of 27th ult., he asks me to point out where he can capture a few megohms in his installations. He has proved the wiring to be in good order and perfect as far as test is concerned. Has he made sure that his pipes are well bushed with proper ferrules where they finish for various switches and ceiling roses? Also, is he sure they have been well protected during progress of plastering, as this is seldom done, and it is surprising to see the way the plasterers pull them about when plastering around them; in fact, everyone who passes has a pull at them; a good idea is either to tape them up well, or insert a Simplex bend temporarily until such time as switches are fixed.

Another point is to observe that rubber coating of wire is brought through the base of switches and ceiling roses, as invariably this is not done; in fact, the wire is more often pared close to patera due to number of wires necessary in looping system.

It is a good plan to varnish everything, and varnish should not be used sparingly, especially on pateras, as modern pateras are very often made of common whitewood, and if not well varnished are sure to absorb the damp.

Now as to distributing boards. The contact pieces should be mounted on good china, great care being taken that it is not chipped in any way, as I have known a single holder to bring a between-mains test down from 15 megohms to ·25 Ω through having the glazing chipped off and being exposed to damp.

Do not use slate as material for mounting connections on. Since writing last I have tested a job with splendidly finished main switch and distributing board, both mounted on enamelled slate bases, and made by one of the best known firms; the result was as follows:—Testing from company's outs whole installation to earth, ·05 megohm. Turned off main switch, got ·07 Ω. Removed main switch and tested mains up to this point, 5·5 Ω. Connected mains across at this point and again tested installation, which gave ·12 Ω. I then disconnected mains at distributing board and got 4·7 megohms up to this point. I tested each circuit separately, and they averaged ·25 Ω. In consequence the

job was not connected. After recommending the better bushing of slate bases and examination of switches and ceiling roses, I went back in two or three days and found that the work had been carried out by a good workman; the result was ·8 Ω whole job to earth. This was in a new building, and shows what a great improvement can be made by extra attention to details, such as fixing switches, ceiling roses and distributing boards; this part of the job, especially the switches and ceiling roses, is very often given to an apprentice to do, as it is thought impossible for him to go far wrong.

Ample space should be provided behind main boards, as even 600-megohm cable will not stand being crushed against a damp wall; and I have discovered numerous earths caused through inattention to this point.

I have no doubt "Foreman" will find his troubles greatly lessened if he cares to follow these points.

As to small contractors getting a good number of consumers there is no doubt, but it is very often at the expense of inefficient wiring and cut prices.

Inspector.

Curious Synchronising Effect.

The following has occurred to me as a possible explanation of the effects mentioned by Mr. F. T. Callis in your last issue.

Suppose the curve A, figs. 1 and 2, to be the volt characteristic of the incoming machine, and B the volt curve of the machine running on the bus-bars on a somewhat

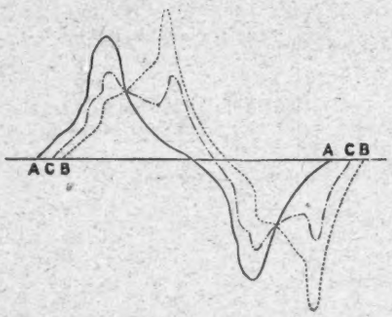


Fig. 1.

inductive load, the effect of which combined with the inductance of the machine will be to throw back the peak of the curve as shown.

Fig. 1 gives the case of the machines approaching synchronism with the incoming machine running slightly slow. As the machines come into step the curve B will overtake the curve A. Suppose that the machines are in the

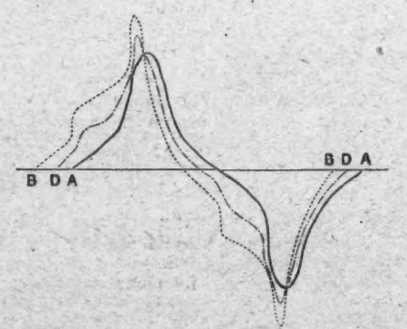


Fig. 2.

relative positions shown by the curves in the figure when the voltmeter needle starts to move. The voltage impressed on the voltmeter and lamp will be a curve which is the resultant between the two curves A and B, and in the case under consideration will be represented by the flat-topped curve C.

Fig. 2 gives the reverse case when the machines are approaching synchronism with the incoming machine running fast. The curve of the resultant voltage will now be peaked as D, as is evident from the diagram.

As is well known, voltmeters which are at all inductive, are affected by the shape of the volt curve, reading over $\sqrt{\text{mean}^2}$ value for flat-topped and under for peaked waves. The brilliancy of the lamps, of course, depends simply on the $\sqrt{\text{mean}^2}$ value, and not on the shape of the curve.

The curves A and B in figs. 1 and 2, are actual curves taken from the same alternator running light and on inductive load (*Electrical World*, New York, 1891).

If this theory is correct, it would seem that the effect should disappear when both machines are run on open circuit. It would be interesting to know if this is so.

H. B. Johnson.

Electrolytic Meters.

Your correspondents, the Electrical Co., "Glimmer," and "Electron," all speak of the efficiency of a meter as a quality independent of its accuracy, whereas this would only be correct were perpetual motion machines the subject under discussion. We contend that the function of a meter is to record electrical energy (*a*) with accuracy and (*b*) with economy, and when it is both accurate and economical, it is a good meter, *i.e.*, an efficient meter.

The motor-meter through which our own works are supplied (respect for ancient dignity prevents our mentioning the make) is 16 per cent. slow, and has a drop of about half a volt at full load. This is efficiency according to the arguments of your correspondents, and we commend these arguments to the notice of the St. Pancras Vestry.

"Glimmer's" curve was apparently plotted for him, as he does not seem to understand it. We must explain to him, therefore, that at 5 amperes it shows a drop of 4 volts, and this is 2 per cent. of 200 volts, as correctly stated by Mr. Haydn Harrison.

The 5-ampere Thomson meter at full load also consumed about *2 volts* in the main coils in the *old 100-volt days*, in addition to the heavy shunt losses, and yet, in spite of this same 2 per cent. consumption of energy, thousands of Thomson meters have been used without a whisper against them so far as this feature is concerned.

The fact is, that this question of drop in volts is brought in as a red herring across the trail to draw attention from the fact that our challenge regarding the infinitely more important point of accuracy has never been accepted by any of our competitors.

The Electrical Co., Ltd., state that they want fair play, but can they point out anything unfair connected with our challenge? Perhaps the reason for their non-acceptance is revealed by an examination of their really absurd figures of last week, which show that their 5-ampere 200-volt meter fully loaded for 1,000 hours only records 200 units. What was their remarkable instrument doing whilst the other 800 units were passing, and will they still contend that the "efficiency" of this unique meter was 97½ per cent.? Their elaborately worked-out results are, therefore, all wrong, in view of the fact that the actual consumption was 1,000 and not 200 units, and they should really be more accurate in their calculations.

They also state that their meter can be read to the one-thousandth part of a unit, and with energy at 6d., the extreme practical utility of this feature calls for no explanation. Bastian meters can certainly be read to one unit, and over a consumption of 200 units one-half per cent. is dead accurate enough.

Last month we booked firm orders for 845 meters, nearly all of which were 1-ampere, 2½-ampere or 5-ampere sizes. On the other hand, there is only one individual in this country to whom we have delivered 24 10-ampere meters for many months past. "Electron" therefore gives us a ready clue to his identity. We will respect his wish to remain anonymous, and merely observe that in our opinion he should in future satisfy himself as to the correctness of his facts where the depreciation of specified goods is concerned. His statements regarding Bastian meters of a smaller capacity than 10 amperes are rash and untrue.

Edinburgh, Glasgow, St. Pancras and the Northern Counties Co. have between them about 2,000 of our 2½-ampere meters, and if "Electron's" mis-statement about the drop in volts over this size at full load can be confirmed, we will forfeit £100 to the Building Fund of the Institution of Electrical Engineers.

To avoid misunderstanding, we must point out that we recommend our 10-ampere and 20-ampere meters for use on motor circuits, where volt drop is immaterial, and on lamp circuits, where the full load is only likely to be used on rare occasions.

We can make meters having a loss of only two volts, if buyers like to pay the price. It is merely a matter of platinum.

The Bastian Meter Co., Ltd.
CHAS. O. BASTIAN, *Managing Director.*

London, N.W., *March 9th*, 1903.

[This correspondence is now closed.—EDS. ELEC. REV.]

Entropy.

I beg leave to ask a small space for a few words on the subject of entropy lately discussed in your columns. What, one may inquire, is the property denoted by entropy? If we reckon entropy from the state of a body deprived of heat, we may write $H/t = \phi$, where H = total heat in the body or substance, t = absolute temperature, ϕ = entropy (*v.* "Maxwell on Heat," cap. 8 and cap. 12).

The availability of H depends on t, hence the greater t is, the greater is the availability, and the less the entropy H/t. Now the maximum work which can be got out of H by a reversible cycle $= H\frac{t - t_o}{t}$, where t_o = lowest available temperature; hence available energy between t and $t_o = H - t_o \frac{H}{t}$ = real dynamical value of H — dissipation.

Hence available energy is less according as H/t is greater, or according as the entropy of the substance is greater. Energy dissipated = $t_o \times$ entropy = intensity factor × quantity factor.

Thus we may say that entropy is a factor of energy, and measures the innate *incapacity to be completely transformed into work* of the heat contained in a body or substance at a given temperature, whatever may be the lowest available temperature. This incapacity varies inversely as the temperature, and the lower t is, the greater is the entropy (*v.* "Maxwell on Available Energy," in cap. 12).

W. P. O.

Bromley, *March 10th*, 1903.

British Trams for Johannesburg.

Under the above title in your issue of March 6th last "Anglo-Africanus" gives credit to the Delagoa Bay Development Corporation for having purchased most of their plant for the Lorenço Marques tramway system in this country.

Whether the credit is really due to the above Development Corporation or to the main contractors for the contract I do not know, but certainly great credit is due to someone. "Anglo-Africanus" goes on to express the hope that the municipality of Johannesburg may follow the example set above by spending the greater portion of their proposed £1,290,000 capital outlay in this country.

It is certainly very much to be hoped that they will do this, but might I suggest that the consulting engineers for the scheme are perhaps the ones who will largely determine this by the form their specification takes. To take a single example. The consulting engineer's report on the type of plant proposed, mentions gas engines of a size for which there has hitherto been no market available to home manufacturers, and which have consequently not been made up to so large a size in this country.

The consulting engineers might therefore at first feel tempted to go to the Continent for these.

On the other hand, however, there are engineering firms in this country whose reputation and guarantees are in every way as solid as those of Continental manufacturers—who are in a good position and willing to manufacture engines of this type up to the largest size for which there may be a market—and it is very much to be hoped that these firms will be consulted before specifications are drawn up based on Continental practice.

The first thoughts of many, on reading the consulting engineer's report on the proposed scheme, has, no doubt, been one of regret that possibly the contract for the engines would go out of the country, but those in a position to know what certain manufacturers in this country are doing in the way of preparing for large engines of this type, feel that there need be no necessity for this.

Any firm of consulting engineers has naturally to study its own position, and would feel reluctant at recommending the adoption of machinery which might give trouble, and be a source of anxiety to them, when working so far away from home; but this anxiety can surely be overcome in the knowledge that our first-class manufacturers have a way of carrying through what they undertake, perhaps more readily than some of their Continental friends.

For engines of this size and type to be placed out of the country at the present time, would be a source of regret not only on the grounds that Continental manufacturers were strengthening their position, but that home manufacturers were retarded in taking up their position in what promises to be an important industry.

Engineer.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Mar. 11th, 1902.		Week ending Mar. 10th, 1903.	
Alexandria	Value £107	Adelaide	Value £2,721
,, Teleph. mat. ..	80	Amsterdam	85
Amsterdam	125	Auckland	40
Auckland. Teleg. mat... ..	1,330	Bangkok	42
Bombay	88	Boca	4,289
Bremen	75	Bombay	104
Buenos Ayres. Teleg. mat. ..	62	Buenos Ayres	8,063
Calcutta	1,361	Calcutta	1,007
,, Teleg. wire	573	Canada, *viâ* United States ..	23
Cape Town	2,256	Cape Town	923
Colombo. Teleg. mat.	286	Colombo	147
Copenhagen. Teleg. wire ..	13	,, Teleg. mat.	206
Durban	673	Delagoa Bay	98
East London	80	Durban	1,841
Fremantle	271	Hamburg	14
Halifax. Teleg. wire	25	,, Teleph. mat.	110
Hamburg	608	Hong Kong	22
Hiago	67	Madras	9
Hobart	22	Malta	10
Hong Kong	91	Melbourne	433
Ostend	80	North Atlantic. Teleg. cable ..	2,150
Perth	650	Odessa	83
Port Elizabeth	624	Oporto	5
Rangoon. Teleph. apparatus ..	420	Ostend	26
Reval	141	Perth	146
Rotterdam. Teleg. mat. ..	98	Port Elizabeth	187
St. Petersburg. Teleg. mat. ..	120	,, Teleg. mat. ..	9,734
Singapore	167	St. Petersburg	60
Stockholm. Teleg. wire ..	60	Sydney	865
Suez. Teleg. insts.	1,496	,, Teleg. mat.	145
,, Teleg. mat.	124	Vera Cruz	2,551
Sydney	248	Wellington	4,680
Wellington	535	,, Teleg. mat.	2,401
,, Teleph. mat. ..	1,880	Yokohama	413
Total ..	£13,911	Total ..	£43,573

Foreign Goods Transhipped.

Cape Town.	Telephones	Value £110
Gothenburg.	Elec. apparatus	.. 31
New York.	Elec. motor	.. 1,200
	Total ..	.. £1,344

Dissolutions and Liquidations.—Messrs. P. Simon, H. Berry and E. Skinner, trading as Simon, Berry & Co., of London, Manchester and Birmingham, have dissolved partnership, Mr. Simon being the retiring member. Messrs. Berry and Skinner will continue trading as heretofore at the same addresses under the style of Berry, Skinner & Co, who will attend to debts.

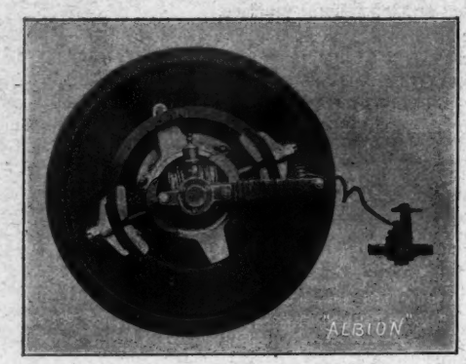
Messrs. E. J. Harris and C. J. Cassé (Bradford Electrical Engineering Co, Trafalgar Street, Bradford) have dissolved partnership. Mr. Cassé attends to debts.

First meetings of creditors and contributories in Hands, Ltd., of Garlick Hill, E.C., are to be held on March 18th.

A meeting of Allan & Adamson, Ltd., will be held at 55, Hatton Garden on April 15th to hear an account of the liquidation from Mr. Wm. Peto.

The matter of Electric Lighting Boards, Ltd. (petition of O. T. Banks), was before Mr. Justice Buckley in the Winding-Up Court on Tuesday. Mr. Ashton Cross said that this petition had been before the Court on several occasions, but now by consent all parties asked for a supervision order to be made in the voluntary liquidation. His Lordship: Very well. Order accordingly.

Electrical Ignition.—We referred in a previous issue to the magneto-system of ignition adopted by the Albion Motor-Car Co., of Glasgow, and shown at the Crystal Palace Exhibition. We now illustrate the magneto and ignition plug; the revolving magnets, mounted on an aluminium spider, and attached to the



Electrical Ignition Device.

fly-wheel, are clearly shown. The fixed H-type armature, wound on either side of the centre bearing, and the single wire to the sparking plug, can also be seen. The mechanism produces a spark at every second revolution of the engine, the circuit being broken when the current is at a maximum.

Trade Announcements.—The businesses of A. G. Sanders, electrical engineer, of Clarence Parade, Cheltenham, and of D. H. Morgan, motor-car engineer, of Clarence Street, Cheltenham, have been combined under the name of Sanders, Morgan and Co., "The Garage," 22, Clarence Street, Cheltenham. The business will now comprise that of electric lighting contractors, mechanical and motor-car engineers, &c., &c. The premises are fully equipped with a complete set of machine tools for all necessary repairs and "Garage" requirements.

Mr. P. Adler, electrical engineer, of East London, has opened a branch of his business in King William's Town, S.A.

The goodwill, patterns and works of Art Panels, Ltd., have been purchased by Panels, Ltd., and they are nearly ready to recommence the manufacture of deeply-pressed wood panels with an assortment of over 300 dies. This is nearly double the number owned by the late company before the fire which financially ruined the company about two years ago. Panels, Ltd., will shortly be issuing a new catalogue of designs. Its address is at 46, Old Bidston Road, Birkenhead.

Reports having been circulated that proceedings have been commenced against the purchasers of Messrs. Holden & Brooke's expansion steam traps, Messrs. Holden & Brooke, Ltd., desire us to state that no such proceedings have been taken against them or any of their customers.

Mr. W. P. Mendham, consulting electrical engineer, has removed from 33, Nicholas Street, to 18, Oakfield Grove, Bristol.

Under "Contracts Closed" last week we gave the address of Goodbrand & Co. as Bradford; this was an error, as the firm's addresses are Britannia Foundry, Stalybridge, and Victoria Street, Manchester.

To meet the wishes of customers in the Midlands, and to expedite work generally, the Phosphor Bronze Co., Ltd, have now, in addition to their two London foundries, established a foundry for the production of castings to patterns or drawings in their alloys of phosphor bronze, gun metal, aluminium, &c., at Bagot Street, Birmingham.

Books Received.—"Specification" for Architects, Surveyors and Engineers when Specifying, for 1903 (No. 6). London: The *Builders' Journal*. 5s. net.

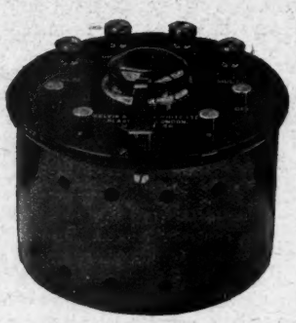
"Continuous Current Dynamos and Motors and their Control," by W. R. Kelsey. London and Manchester: The Technical Publishing Co., 1903. 5s. net.

"Specification for a Lancashire Boiler and Boiler Seating," by "Inspector." London and Manchester: The Technical Publishing Co, 1903.

"Linolite."—In our notice of this system of electrical illumination last week, omission was made to state that it was not only invented by Mr. Beuttell, but also patented by him, and that "Linolite" is the company's registered trade mark. The installation of linolite at Messrs. Swan & Edgar's, in Regent Street, was carried out by Messrs. Freeman & Co., of Swallow Street, W.

Travelling Carrier Fitting.—We have received from Mr. A. Fearnhead, electrical engineer, of 354, Caledonian Road, London, N., a pamphlet illustrative of his registered design for an electric light travelling carrier fitting, consisting of a counter-weighted rise and fall pendant suspended from a small carrier travelling along a rod which can be fixed to the ceiling. This fitting will be an acquisition in drawing offices and for any purpose where it is desired to have a movable source of light without obstructing the desk or bench.

Electrostatic Voltmeters.—An improved form of Lord Kelvin's multicellular electrostatic voltmeters has lately been put on the market by Messrs. Kelvin & James White, Ltd. The chief improvements in this new pattern are a longer scale, increased deadbeatness, and the insulation of the case from both terminals. The instrument is made with either a 6-in. or a 10-in. scale. The 6-in. instrument is approximately the same size as the well-known vertical scale pattern, and this increased length of scale has been obtained without in any way increasing the distance which the instrument projects from the switchboard. The bracket which supports the instrument differs slightly from the older form, but it is fixed in the same manner to the board. A hole, slot and plane support is provided on the instrument itself, so that the levelling can be carried out quickly and



Kelvin and White Multiplier.

accurately. Some engineers consider the instruments too delicate for ordinary use, but on this point it is interesting to note that there are fewer breakages in this class of instrument than in any other type. The increased deadbeatness also is a great advantage, seeing the instruments can be used both for traction and lighting. The makers guarantee an accuracy of one-third of 1 per cent. on this particular form of instrument. The instrument can be made for any range from 80 to 1,400 volts. For ranges above this the Dial type is recommended. A valuable adjunct to these instruments is the multiplier lately put on the market by the same firm. This multiplier, which we illustrate above, enables any desired range to be obtained on one instrument, but the standard multiplier gives four ranges from 30 to 600 volts. The instrument, when used alone or with the multiplier, can be used either for direct or alternating current.

Steam Turbines.—The steam turbine plant of the Hartford Electric Light Co., Connecticut, which at present consists of a 2,000-H.P. set, is to be duplicated in the near future by machines built by the contractors for the original installation, the Westinghouse Machine Co. This is the first American plant where steam turbine units of large size have been installed, and they have been a complete success. The foresight displayed by the Westinghouse Companies in taking up the manufacture of these machines is amply justified by the fact that the aggregate power of steam turbine sets completed, in hand, and on order does not fall far short of 100,000 K.W., a very large proportion of which will emanate from the British Westinghouse works at Manchester.

Three-phase Plant for North-country Chemical Works.—An order has just been placed with Messrs. C. A. Parsons and Co. for two 100-K.W. three-phase turbo-alternators, which will form the first portion of the generating plant for an important scheme of electric lighting and power in a large chemical works in the North. The order has been placed through Mr. Frank Broadbent, the consulting engineer for the company. Turbines have been chosen, as it is a portion of the engineer's scheme to utilise the exhaust steam for heating and boiling purposes, in which any trace of oil would be fatal to the delicate processes involved. It is anticipated that by this means the whole of the power and heating will be obtained with the consumption of very little more coal than was previously used for heating purposes only. The alternators will be star-wound, giving 230 volts for lighting and 400 for power.

Natal Electrical Imports.—The value of the electrical fittings imported into Natal last year is returned at only £56,000, as compared with £91,000 in 1901.

Electrical Machinery Exports.—With the new year a separate classification is given in the monthly returns of the Board of Trade to the exports of British-made electrical machinery. In January last such exports attained a value of £42,029.

German Foreign Trade in Electrical Machinery.—The German Customs returns relating to the imports and exports of electrical machinery during the past year have just been issued. To deal first with the imports of foreign electrical machinery into Germany, these amounted to only 1,434 tons (valued at £114,750) as compared with 2,181 tons (£174,500) in 1901. Passing now to the exports, these show a large increase, last year's shipments from Germany being returned at 13,450 tons (valued at £1,076,000) as contrasted with 12,460 tons (£996,750) in 1901.

Infirmary Installation. — Messrs. D. Firth & Son electrical contractors of Manchester, have recently fitted up the Dewsbury and District General Infirmary with the electric light, some 220 lamps being installed, and the whole of the wiring carried out in earthed steel tubing. The installation includes a Röntgen ray apparatus, the gift of Mr. S. Mitchell.

Annual Dinner.—The first annual dinner of the Electric Light Insurance & Maintenance Co., Ltd. (maintenance department), took place at the "Horse Shoe" Hotel, Tottenham Court Road on 27th ult., the chair being occupied by Mr. G. R. Wellington, and the vice-chair by Mr. W. Lowry (installation department).

Mill Driving.—Messrs. H. V. Kramer & Co., Manchester, are to drive the York Street Mills of Messrs. Samuel Renshaw & Sons, Bury, temporarily by electricity, during alterations and additions.

Fire Appliances.—The May-Oatway Co., of Glasgow, has booked orders through Messrs. Drake & Gorham for the installation of its system in the premises of Messrs. Stewart & M'Donald, of Glasgow, and of Messrs. Tootal Broadhurst, Lee & Co., of Manchester, also a number of other important establishments in different parts of the kingdom.

The Simplex Variable Speed Gear.—The British Simplex Gear Co., of Kensington, W, are introducing a somewhat novel form of mechanism, Mr. W. N. Dumaresq's patent, which is intended to overcome the long-standing difficulty of gradually varying the speed while continuing to transmit power, between the extreme limits of 1 to 4 with the standard type of gear box, or by the use of a third drum with a range of 1 to 20. Briefly the gear consists of two drums, each having a series of small toothed pinions mounted on roller clutches and supported on small cross arms, which are capable of moving along radial slots cut in the sides of the drum. The effect of the roller clutch is to lock the pinion in the pulling direction of the chain and leave it free in the reverse direction. The radial movement of the arms and pinions is effected by rotating two scroll plates, carried on either side of the drum, the scroll plates having spiral threads on their faces, into which the ends of the small cross arms engage (see fig. 2). The rotation of the scroll plates is effected by the simultaneous moving in or out of two flat toothed racks having teeth cut in opposite directions and lying in slots cut in the axles carrying the drums. The racks engage in similar teeth cut in the bosses of the scroll plate, the arrangement being a modified form of skew gear. The method of securing this operation will be understood from fig. 1. The transmitting chain engages in the outermost teeth of the pinions, which being then locked, rotate with the drums, but on the diameter of the drums being altered, each pinion rotates on its own axis, sufficiently to allow of the chain adjusting itself. The gear runs practically noiselessly in oil, and is easily adjusted. Its immediate adaptation to motor car work is intended, and no doubt it will find many uses in both mechanical and electrical industries.

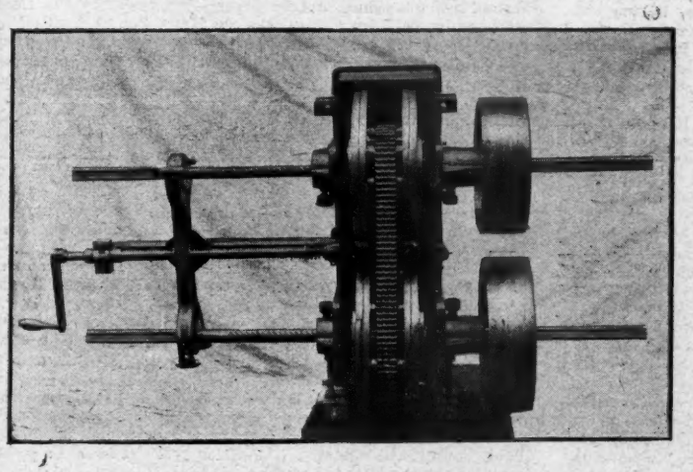


Fig. 1.

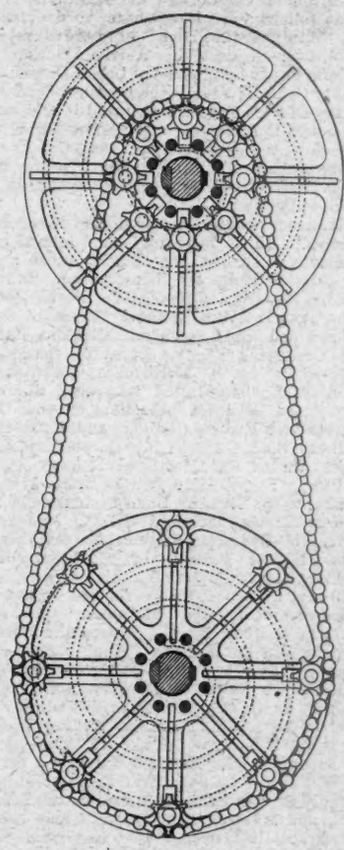


Fig. 2.

Simplex Variable Speed Gear.

Parliamentary Petitions.—Numerous petitions have recently been presented to Parliament against electrical schemes, and the following notes have been prepared by our Parliamentary correspondent each day as they have been filed. Opposition to the Antrim, Down, Armagh and Belfast Electric Power by the Belfast Corporation and the Belfast Harbour Commissioners; to the Bournemouth Corporation by the Christchurch and Poole Corporations and the Dorsetshire County Council; to the Brighton Corporation by the London, Brighton and South Coast Railway; to the Carmarthenshire Electric Power by the Llanelly Urban District Council and the Carmarthenshire County Council; to the Hamilton, Motherwell and Wishaw Tramways by the Provosts, &c, of Wishaw and Motherwell, Clyde Valley Electrical Power Co., the Glasgow Corporation, Caledonian Railway, Provost of Hamilton, Lanark County Council and North British Railway Co.; the London, Brighton and South Coast Railway by the Uckfield U.D.C.; North-Western Electricity and Power Gas by the Corporations of Hyde, Stalybridge and Hanley; to the Nottinghamshire and Derbyshire Corporation by Mr. E. M. Mundy; to the Oldham Corporation by five petitioners; and to Poole and District Electric Traction by the Christchurch Corporation.

Petitions have been deposited in the Private Bill Office of the House of Commons against the following Bills:—Blackheath and Greenwich District Electric Light by the Greenwich Borough Council and the Penge U.D.C.; against the Central London Railway by the Ecclesiastical Commissioners, the Duke of Norfolk, St. George's Hospital, Westminster Electric Supply Corporation, Carron Co. and the Kensington Borough Council; against the Charing Cross, Euston and Hampstead Railway by the South-Eastern and Chatham Railway Cos.; the City and North-East Suburban Electric Railway by the East London Water Co., Hackney Borough Council, and South-Eastern and Chatham Railway Cos; against the City and South London Railway by the London, Brighton and South Coast Railway; against the Clapham Junction and Marble Arch Railway (No. 1) by the London and Brighton Railway and the Westminster Electric Supply Corporation; against the Erith Tramways by the South-Eastern and Chatham Railways and two others; against the Great Northern, Piccadilly and Brompton Railway (new lines and extensions) by the Ecclesiastical Commissioners, the Duke of Norfolk, and the Kensington Borough Council; against the Kingston-upon-Hull Corporation by Mr. John E. Walker and others, and Beverley and Barmston Drainage Commissioners; against the Leigh Corporation by the West Houghton Urban District Council, Lancashire and Yorkshire Railway Co., and the Lancashire County Council; against the London County Council (Electric Supply) by South Metropolitan Gas Co., and Westminster Electric Supply Corporation; against the London, Tilbury and Southend Railway by the Barking Town Urban District Council; against the London United Tramways by the Twickenham Urban District Council and East and West Molesey Urban District Council; against the Metropolitan District Railway (Works) by the South-Eastern Railway Co. and South-Eastern and Chatham Railway Co.'s managing committee; against the London and North-Western Railway by St. George's Hospital, London, Brighton and South Coast Railway Co., and Westminster Electric Supply Corporation; against Romford and District by the Essex County Council; against the Seaforth and Sefton Junction Railway by Litherland Urban District Council, Earl of Sefton, Lancashire and Yorkshire Railway Co., Liverpool Corporation, Edmund Knowles Muspratt, and Southport and Cheshire Lines Extension Railway Co.; against the Ulster and Connaught Light Railway by Midland, Great Western Railway of Ireland Co.; against Watford and Edgware Railway by Mr. Robert Palmer Tebb; against Wood Green Urban District Council by Tottenham School Board; and

against Woolwich Borough Council by the South Metropolitan Gas Co.

Petitions in opposition to the following Bills have been deposited in the Private Bill Office of the House of Commons:—Central London Railway by Lord Iveagh, the trustees of the Stock Exchange and the City Council of Westminster; the Charing Cross, Euston and Hampstead Railway by the City Council of Westminster; City and North-East Suburban Electric Railway by the Colonial Bank; the City and South London Railway by Messrs. T. Poulten & Sons; Clapham Junction and Marble Arch Railway (No. 1) by the City Council of Westminster; the Great Northern, Piccadilly and Brompton Railway (new lines and extensions) by the City Council of Westminster; the Great Northern, Piccadilly and Brompton Railway (various powers) by the City Council of Westminster; the London County Council (electric supply) by the City Council of Westminster; the London, Tilbury and Southend Railway by the Essex County Council; the Newcastle-upon-Tyne Electric Supply by the Duke of Northumberland; the Seaforth and Sefton Junction Railway by the Waterloo-with-Seaforth Urban District Council; and the South Shields, Sunderland and District Tramways by the South Shields Gas Co. and the South Shields Corporation.

The following petitions have been deposited in the Private Bill Office of the House of Lords praying to be heard in opposition:—Against the Antrim, Down, Armagh and Belfast Electric Power by the Newry Urban District Council and the Down County Council; against the Bradford Corporation by the Clayton Urban District Council; against the Oldham Corporation by the Brighouse Corporation; and against the Willesden Urban District Council by the Gas Light and Coke Co. The London and North-Western, the Midland and the North London Railway are petitioning in the House of Commons against the Metropolitan District Railway (Various Powers) Bill.

Numerous additional petitions have been presented against electrical Bills, including the following, in the House of Commons:—Against the Baker Street and Waterloo Railway (Transfer) Bill by the Metropolitan Railway Co., the Central London Railway and the L.C.C.; Beckenham U.D.C. by nine petitions, including the National Telephone Co., Lewisham Borough Council and the London and Chatham Railway Co.; Blackheath and Greenwich Electric Light by the L.C.C.; Central London Railway Co. by the Metropolitan Railway, Metropolitan District Railway, London United Tramways, Charing Cross, Euston and Hampstead Railway, promoters of the Clapham Junction and Marble Arch Railway, the City and North-East Suburban Electric Railway, the L.C.C., the City Corporation, and 35 others; Charing Cross, Euston and Hamstead Railway by the Central London Railway, North Metropolitan Tramway Co., L.C.C., and four others; to the Cheshire Lines Committee by the L. & N.W. Railway, Mersey Docks, Stretford U.D.C., Manchester Corporation and Liverpool Overhead Railway; to the City and North-East Suburban Electric Railway by the Metropolitan and Metropolitan District Railways, Great Eastern Railway, L.C.C., Central London Railway, City and South London Railway, North Metropolitan Tramways Co., and 12 others; to the City and South London Railway by the Metropolitan Railway, L.C.C., Metropolitan District Railway, Charing Cross, Euston and Hampstead Railway, City and North-East Suburban Electric Railway, and seven others; to the Clapham Junction and Marble Arch Railway (No. 1) by the Great Northern, Piccadilly and Brompton Railway, L.C.C., Metropolitan District Railway, Central London Railway, National Telephone Co., and 12 others; to the Coventry Electric Tramways by the National Telephone Co. and the London and N.W. Railway Co.; to Dover Corporation by the Dover Electricity Supply Co.; to Erith Tramways by the L.C.C., National Telephone Co., and seven others; to the Great Northern, Piccadilly and Brompton Railway (new lines and extensions) by the Metropolitan Railway, London United Tramways, Central London Railway, and 14 others; to the various powers Bill of the same company by seven petitioners; to Kingston-upon-Hull Corporation by five petitioners; to the Leigh Corporation by 17 petitioners, including the South Lancashire Tramways Co.; to the London County Council (Electric Supply) by the St. James's and Pall Mall Electric Light Co., the London Electric Supply Corporation, Central Electric Supply Co., National Telephone Co., and seven others; to the London, Tilbury and Southend Railway by 12 petitioners; to the London United Tramways by the Twickenham and Teddington Electric Supply Corporation and 11 others; to the Metropolitan District Railway (Works) by the Metropolitan Railway, Central London Railway, City and North-East Suburban Electric Bill, City and South London Railway, and 13 others; to the Newcastle-on-Tyne Electric Supply by the Newcastle Corporation, Tynemouth Corporation, and six others; to the North-West London Railway by the Metropolitan Railway, Great Northern, Piccadilly and Brompton Railway, Metropolitan District Railway, Clapham Junction and Marble Arch Railway, Central London Railway, and eight others; to the Plymouth Corporation by three petitioners; to the Romford and District Tramways by the Great Eastern Railway Co., to the Seaforth and Sefton Junction Railway by five petitioners; to the South Shields Corporation by the County of Durham Electric Power Supply and County of Durham Electrical Power Distribution Co., the South Shields Tramways, the British Electric Traction Co., and three others; to the South Shields, Sunderland and District Tramways, four petitioners; to the Stroud District and Cheltenham Tramways, the Great Western Railway and the Midland Railway; to the Ulster and Connaught Light Railway by the Great Northern Railway Co. of Ireland and another; to the Watford and Edgware Railway by the Charing Cross, Euston and Hampstead Railway, the National Telephone Co., and nine others; to the Wellingborough and District Tramroads by the London and North-Western Railway Co.; to the West Cumberland Electric Tramways by three U.D.C's.; to the Wood Green Urban District Council by the North Metropolitan Electric Power Supply Co. and the Herts County Council.

In the House of Lords further petitions have been presented against the following Bills:—Antrim, Down, Armagh and Belfast Electric Power by the Newry Port and Harbour Trustees and the Great Northern Railway Co.; to the Carmarthenshire Electric Power by the G.W.R. and London and South-Western Railways; to the Chatham and District Light Railways by the Rochester Gas Co. and the Brompton Water Co.; to the Cleveland and Durham County Electric Power by the West Hartlepool Corporation; to the Dudley, Stourbridge and District Tramways by the G.W.R.; to the North Cheshire Tramways by the Stretford Urban District Council; to the North-Western Electricity and Power Gas Co. by the Cheshire Lines Co.; the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board and nine others; to the Nottinghamshire and Derbyshire Tramways by the Derby County Council and Lord Middleton; to the Oldham Corporation, four petitions; to the Salford Corporation, two petitions; to the Shropshire, Worcestershire and East Derbyshire Electric Power by two petitioners; to the Somerset and District Electric Power by the Bristol Tramways Co., the G.W.R and two others; to the West Bromwich Corporation by the L. and N.W. Railway; to the Willesden Urban District Council by the L. and N.W. Railway; and to the Worthing Corporation Tramways by the British Electric Traction Co. and the National Telephone Co.

In the House of Lords further petitions had been deposited in opposition to the Antrim, Down, Armagh and Belfast Electric Power by the Antrim County Council and another; to the Birmingham Corporation Bill by the City of Birmingham Tramways Co. and the Great Western Railway; to the Bournemouth Corporation Tramways by the Poole and District Electric Traction Co., the Bournemouth and Poole Electricity Supply Co. and one other; to the Carmarthenshire Electric Power Co. by two petitioners; to the Chard Corporation Gas and Electricity by the Chard Gas Co.; to the Exeter Corporation Bill by the Great Western Railway; to the Hove, Worthing and District Tramways by the Southwick U.D.C.; to the North-Western Electricity and Power Gas Co. by 33 petitioners, including the Potteries Electric Traction Co. and the North Staffordshire Tramways Co.; to the Nottinghamshire and Derbyshire Tramways by the Derbyshire and Notts Electric Power Co., the Notts County Council and seven others; to the Oldham Corporation by six objecting local authorities; to the Pontypridd U.D.C. Bill by the South Wales Electric Power Distribution Co. and frontagers; to the Poole and District Electric Traction Co. by the London and South-Western Railway Co.; to the Preston and Horwich Tramways by the Preston Gas Co.; to the Rochester Corporation Tramways by six petitioners; to the Salford Corporation by the Manchester Corporation and another local body; to the Shropshire, Worcestershire and East Denbighshire Electric Power by the promoters of the North-Western Electricity and Power Gas Bill and the Oldbury U.D.C.; to the Somerset and District Electric Power by the County Councils of Gloucester, Wilts and Somerset, and four others; to the Willesden U.D.C. by the North Metropolitan Electric Power Co. and two others; and to the Worthing Corporation Tramways by one petitioner.

On Friday it was found that Standing Orders in the House of Commons had been complied with in the case of the Blackheath and Greenwich District Electric Light Bill, and the Lanarkshire Electricity and Refuse Destructor.

Coventry Electric Tramways Bill.—The Coventry Electric Tramways Co., which have already expended £103,600 on their undertaking, have this session a Bill before Parliament for constructing further additional tramways. On Friday they presented a petition asking for an additional clause in the Bill, with the object of making it clear that the Borough Council shall have power to work the tramways when the period arrives for them to purchase the undertaking. It was found that Standing Orders had not been complied with in respect of the additional provision, and accordingly the Bill will go before Standing Orders Committee.

Baker Street and Waterloo Railway (Transfer) Bill.—Mr. Kimber has given notice to move, on the second reading of the above Bill, "That it be an instruction to the Committee to strike out all powers enabling the promoters to take, use or damage the property of other people, or of the public, without paying compensation." He will similarly move on the other tube railway Bills.

London County Council (Electric Supply) Bill.—Capt. Jessel has given notice that he will move the rejection of this Bill on second reading.

On Monday Mr. Campion found that the Standing Orders of the House of Lords had been found proved in the case of the Hamilton, Motherwell and Wishaw Tramways Bill.

ELECTRIC LIGHT AND POWER NOTES.

Aldershot.—The E.L. Committee has recommended the following extensions of plant (subject to the sanction of the L.G.B. being obtained for the proposed loan):—Babcock & Wilcox boiler, combined Willans-Parker steam dynamo, pipe work, and electrically-driven condensing plant. The running contract is still in the hands of Messrs. T. Parker, Ltd.

Audenshaw.—The U.D.C. has decided to put pressure upon Manchester Corporation, so that Hooley Hill and district can be supplied with electricity without further delay.

Batley.—The T.C. has declined to negotiate with the Heckmondwike U.D.C. with regard to the proposed supply of energy by the latter body to premises within the Batley boundary.

Bootle.—The T.C. has applied for a loan of £40,000 to cover the cost of purchasing additional plant and cables and of extending the works.

Brixham.—The U.D.C. has agreed conditionally to the laying of mains in its district bordering on Kingswear by the Urban Electric Supply Co. of Dartmouth, who are proposing to light Kingswear.

Brussels.—The municipal authorities of Brussels have decided to establish a large electricity works on the outskirts of the city to generate current at high pressure, and transmit the same to the existing secondary stations in the city, where it will be transformed to low pressure. There are three existing secondary stations, the plant at the A station comprising five 500-H.P. compound steam engines, each driving two four-polar dynamos, giving 1,100 amperes at 110 to 130 volts, and three 1,000—1,300 effective H.P. tandem steam engines, each directly connected to a 220—260-volt Pieper dynamo, a battery of Tudor accumulators of a capacity of 7,800 ampere-hours, and three transformers of 500 H.P. each, converting the 220-volt current into three-phase current at 5,000 volts, 50 periods, and transmitting the same to station B, where it is transformed down to 220 volts. The plant at station B, in addition to the three transformers, comprises four gas engines and dynamos of 120 H.P., giving 310 amperes at 250 volts; two gas engines and dynamos of 120 H.P., developing 310 amperes at 125 volts, and a 2,800 ampere-hour battery of Julien accumulators. The plant at station C consists of four dynamos (130 amperes at 130 volts), and two dynamos (130 amperes at 260 volts), driven by four 60-H.P. gas engines, two dynamos (310 amperes at 250 volts) actuated by a 120-H.P. gas engine, a 2,800 ampere-hour battery of accumulators, and a smaller set of 1,000 ampere-hour capacity. The cables connecting stations A and B, and conveying the 5,000-volt current, have a cross-section of 3 × 180 sq. mm, and are so situated, that they may be used to conduct the current from the projected new exterior station. The latter will be established at Laeken, on the banks of the canal, and will be connected by a short branch with the Schaerbeck railway station. Station A is 3¾ kilometres from the proposed new plant; station B is 5$\frac{3}{10}$ kilometres away, while the distance between stations B and C is 3 kilometres. The power which the various stations are estimated to be required to furnish in the winter of 1904 is—A, 2,225 KW.; B, 1,430 KW., and C, 190 KW., a total of 3,845 KW., so that the projected new plant will require to have at first a capacity of, say, 6,845 H.P.

According to the scheme, it is proposed to provide this by equipping the new and existing stations with the following plant:—

The new exterior station—

Three new 2,000—2,600 H.P. engines.

Three 1,000—1,300 H.P. engines taken from station A.

Six new boilers with 366 sq. metres heating surface each.

Six boilers taken from station A with 226 sq. metres heating surface each.

Two boilers taken from station A with 366 sq. metres heating surface each.

Three alternators of 1,500 kilo-volt-ampere capacity.

Three alternators of 750 kilo-volt-ampere capacity.

Two exciters of 200 kilowatts capacity.

One battery of accumulators.

Station A.—Four engines and dynamos of 750 kilowatts using three existing generators.

One balancing set of 200 kilowatts.

Station B.—Three existing engines and dynamos of 375 kilowatts.

Three existing engines and dynamos of 375 kilowatts, to be taken from station A.

One balancing set of 100 kilowatts.

Station C.—Three engines and dynamos of 100 kilowatts.

One balancing set of 50 kilowatts.

Mains.—Six cables 3½ kilometres long, and 3 × 180 sq. mm. section between new exterior station and A. Two cables 3 kilometres long, and 3 × 30 sq. mm. section between B and C.

It has also been decided to establish a sub-station, D, of 300 KW. capacity, under the Palace of Justice, 2½ kilometres from B, and a sub-station, E, of 200 KW. capacity, under an annex to the Palace of Cinquantenaire, 2⅝ kilometres from B.

The increase in the maximum requirements is estimated at 363 KW. per year, and the scheme provides that the plant to be ready by October 1st, 1904, shall be capable of meeting the 1905 demand. The buildings of the new station to be erected will be capable of accommodating five sets of 2,000 H.P. engines and dynamos, and three sets of 1,000 H.P., provision, however, being made that both the engine and boiler houses can be doubled in size later.

On the basis of the programme outlined above, the municipal authorities of Brussels are inviting tenders until May 1st next for the carrying-out of the work. It is pointed out that the scheme above given is merely a draft, and that firms tendering for the work may submit alternative projects. Tenders must be accompanied by descriptions and drawings, as well as a detailed estimate. The work is to be commenced on February 1st, 1904, and must be completed in time to allow the lighting in the winter of 1904 to be carried on, the installation in all the different stations to be entirely finished by October 1st, 1905. The successful firm will be required to deposit a sum as guarantee equal to 2 per cent. of the value of the contract, this being returnable on the provisional acceptance of the plant by the municipality immediately after October 1st, 1905. The mains must be guaranteed for a period of six years. Further clauses in the draft scheme provide that, all other things being equal, preference will be given to the firm which will employ the largest proportion of Belgian machinery and material, and that all the tenders submitted, which must be written in French, will remain the property of the municipality. Full particulars of the projected plant can be obtained from the College des Bourgmestre et Echerins, Hotel de Ville, Brussels.

We would suggest that any British manufacturers who put in for this work should examine carefully the conditions of the contract and the guarantees that the terms agreed upon will be properly fulfilled. We rather fancy that some former contractors in this country are by no means satisfied with the dealings of the Brussels municipal authority, nor with the qualifications of its electrical advisers to make a proper comparison of the merits of competitive tenders. We merely make these remarks in order that our manufacturers may be on their guard.

Clacton.—The Council has decided to obtain expert opinion as to the advisability of obtaining statutory powers for the provision of electric lighting and tramways.

Clermont-Ferrand.—An interesting hydro-electric plant is now being installed by the gas company of Clermont-Ferrand, to reinforce their existing electrical plant. The new works are situated on either side of the River Sioule, below the dam, which will be 30 metres in height with a maximum width of 25 m., forming a lake about 6 km. long, with an average breadth of 120 m. The turbines will be six in number, of 1,000 H.P. each, of the horizontal "Francis" type. They are made for a head of 20 to 25 metres, with a minimum of 6 m^3 of water per second. Each turbine will be connected to a Westinghouse three-phase alternator of 800 KW. at 1,000 volts, 50 periods and 333 r.p.m. The voltage will be stepped up to 20,000 by means of Westinghouse single-phase transformers. The overhead transmission line will be double, and about 45 km. in length. The poles and cross-arms will be of wood, the latter being boiled in paraffin and then covered with a layer of tar. The setting up of the line, as well as the construction of the electrical and mechanical apparatus, has been undertaken by the Société Anonyme Westinghouse of Havre. Clermont-Ferrand is a great centre for the rubber trade, and considerable development of the existing works will be expected with the advent of cheap electric power.

Colchester.—It is understood that the E.L. Committee will shortly be able to supply the whole of the power required for the tramways—between 200,000 and 300,000 units per annum.

Conway.—The promoters of the Llandudno and Colwyn Bay light railway have withdrawn the clause seeking power to supply electricity in the borough. The Corporation has intimated that it would support private enterprise in regard to the supply of electricity on suitable terms.

Dewsbury.—The T.C. has decided to adopt arc lighting in four roads in the town.

Darlington.—A joint report is to be presented to the T.C. on the comparative cost of street lighting by gas and electricity. It is proposed to reduce the price of electricity for power during the daytime.

Dumfries.—The E.L. Committee, in the course of its negotiations with Messrs. Crompton & Co., Ltd., regarding the establishment of an electric supply for the town, has received an intimation that the company cannot agree to the proposed modifications in the terms of the lease and the price to be charged, except on special conditions.

East Barnet Valley.—The L.G.B. has informed the U.D.C. that, in view of the strong opposition of the ratepayers at the recent inquiry, and the division of opinion of the U.D.C. itself, the L.G.B. will defer its decision until after the election of District Councillors in April next, so that the ratepayers may be able to express their opinion on the question with the full knowledge of the facts revealed by the inquiry.

Eccles.—The T.C. has decided to adopt electrical prepayment meters for small consumers, and to increase the public arc lighting.

Festiniog.—The U.D.C. has completed arrangements with the Yale Electric Power Co. as regards lighting Blaenau and Festiniog village.

Glasgow.—The city electrical engineer, Mr. Chamen, has proposed that his department should obtain a further supply of energy from the tramways department, and that arrangements be made for delivering a three-phase supply to the Waterloo Street works.

Hampton.—The U.D.C. has decided to oppose the Bill of the Hampton Court Gas Co. on the ground that if it were granted the Council would lose its powers under the E.L. prov. order.

Hartlepool.—The T.C. has decided to petition against the Cleveland and Durham County Electric Power Bill.

Hebden Bridge.—At a ratepayers' meeting the Council's project for the electric lighting was rejected by 188 votes to 142, and another motion, in favour of the Halifax Corporation proposals, was lost by 278 votes to 98. Ultimately the scheme by which the U.D.C. proposes to establish its own works was adopted, after all.

Ilfracombe. — Edmundson's Electricity Corporation, Ltd, which took over the U.D.C.'s prov. order in December, 1901, has agreed to supply energy for public lighting at 7d. for the first hour, and 2d. afterwards, and for private lighting at 7d. and 3d. per unit. The cables in the compulsory area are to be laid before the end of May.

Liverpool.—The charges for the rental of meters are to be for 5-ampere meters 1s. per quarter; 10-ampere meters 1s 6d. per quarter; 25-ampere meters 2s. per quarter; 50-ampere meters 2s. 6d. per quarter: 100-ampere meters 3s. per quarter.

London.— Bermondsey.—The Lighting Committee reports that the County of London and Brush Provincial Electric Lighting Co. is supplying energy outside its area, and has disregarded the Council's request as to disconnecting. The Council intends to approach the B. of T. on the matter.

Southwark.—The E.L. Committee has written the Brush Provincial Electric Lighting Co. that the latter were misinformed as to the Council's seeking a supply in bulk.

Hornsey.—Municipal trading has here taken the form of the free-sample system, the U.D.C. supplying electricity to everyone who has been "connected," free for a fortnight.

Stepney.—Reduced charges for energy for power purposes will come into effect directly after the close of the present financial year, viz., on the 1st prox.

Hampstead.—In the King's Bench Division a money-lender, of Russell Street, Covent Garden, sued four directors of the Hampstead Electric Supply Co.—Messrs. C. P. Casson, Arthur Watling, Edward Jas. Read and the Chevalier Julio Soares for advances made on bills. In all 12 promissory notes were given. The first four were met, but the others were not, and plaintiff claimed the balance of £1,865 4s. with interest. Judgment was entered for plaintiff for £1,937, with costs.

Ludlow.—The U.D.C. has received an intimation from the B. of T. that unless it is going to utilise its electrical powers they will revoke the prov. order. The U.D.C. has decided to undertake an electric lighting scheme in connection with the refuse destructor.

Manchester.—The Electricity Committee has recommended the following reduced charges for motive power:—1½d. per unit to consumers using their demand for 48 hours and upwards per week, and 2½d. to shorter time consumers, with the object of encouraging the use of electricity and of more fully utilising the plant. No reduction is recommended for current for lighting purposes.

In order to overcome the vibration nuisance at Bloom Street station and the threatened injunction, the E.L. Committee has adopted a scheme of Prof. Perry's for modifying the engines, and so removing the cause of complaint.

Monmouth.—The T.C. has agreed to the following wiring conditions:—(1) That to purchase the installation the applicants pay down one-tenth of the cost on completion of installation, the balance to be spread over a period of not less than six years; (2) To rent the installation the applicants pay the Corporation a fee for cost of specifications, and 5 per cent. by quarterly payments, on the cost of the installation, which would remain the property of the Corporation. The engineer said £300 would cover the expense of wiring, and that the initial outlay would, in his opinion, bring a revenue equal to £300 a year.

Mountain Ash.—The U.D.C. has decided to apply for an extension of time in which to carry out the prov. order for electric lighting.

Merton.—The Parish Council has requested the Croydon R.D.C. to apply for a prov. order to enable it to supply electricity for lighting and motive power. Wimbledon U.D.C. is seeking similar powers, and its application is to be opposed.

Middleton.—The T.C. has asked the Bury and Salford Corporations and the Radcliffe U.D.C. upon what terms they will supply electricity to the borough.

Nairn.—The T.C. has decided to open negotiations with Messrs. Crompton & Co., London, with a view to the transference of the electric lighting provisional order.

Natal.—At a recent meeting of the Elandslaagte Coal Co., held in Durban, the manager stated that the whole of the coal was now mined by electrical machinery worked by natives.

Newcastle-on-Tyne.—The Corporation Mark s Committee has refused to allow the Electric Supply Co. to lay an electric lighting cable through the Market place.

Newport.—The Electricity Committee has instructed the engineer, Mr. Collings Bishop, to proceed with the erection of a new sub-station and extension of mains, and has authorised the purchase of a 100-kw. motor and one of 75 kw. for the purpose of running the Llanarth Street works with power derived from the new power station during times of light load.

Newquay.—The U.D.C. is considering the question of introducing electric light into the town.

Penzance.—The T.C. has decided by 8 votes to 5 to ascertain upon what terms private companies will be prepared to supply the Corporation with electric light. The E.L. Committee had recommended the Council to carry out the order itself at an estimated outlay of £22,840.

Redditch.—The U.D.C. has decided to obtain expert opinion on the present position and future development of the undertaking. A profit of £214 has been made during the year compared with a small loss in the previous year.

Romford.—The U.D.C. has withdrawn its opposition to the Bill of the Empire Electric Light and Traction Co., who have complied with all the Council's requests.

St. Annes.—A L.G.B. inquiry was held recently into an application of the Council to borrow £12,000 for electric plant to supply energy to the Blackpool and Lytham Tramways. The Blackpool Corporation, the Lytham U.D.C. and the St. Annes Land Co. were represented. The Council refused to produce the draft agreement with the tramway company.

St. Helens.—The L.G.B. has sanctioned a loan of £7,600 for electricity purposes. Further loans of £3,520 for E.L. purposes, and £4,732 for tramway purposes are to be applied for.

Sale.—The U.D.C. is prepared to supply electricity for light and power purposes. The rate for lighting is 6d. per unit up to 100 units per kw. of maximum demand, and 3d. in excess of 100 units. Charges for power by arrangement.

Southampton.—The T.C. has decided to apply to the L.G.B. for a loan of £2,800 for an additional feeder, including three spare ducts for future extensions in the Shirley district.

Sunbury.—The U.D.C. will not oppose the London United Tramway Co.'s Bill, on condition that the consent of the local Councils is obtained before supplying electricity for lighting purposes.

Taunton.—As the result of the continued agitation with regard to the discharge of an employé from the electricity works, and the trouble about the electricity meters, which we reported some time ago, Alderman Potter, chairman, and several other members of the E.L. Committee formally resigned on Tuesday last, but the Council unanimously asked them to reconsider their decision. The Mayor criticised the action of the borough electrical engineer in writing to the local paper at the time of the trouble; and a petition was presented praying for the reinstatement of the official who had been discharged. This is the sort of thing that must be expected under municipal control.

Tynemouth.—In order to secure a *locus standi* the T.C. has decided to oppose the Bill of the Newcastle-upon-Tyne Electric Supply Co.

Wakefield.—The Corporation has received the sanction of the L.G.B. to the borrowing of £15,000 for electric lighting purposes, repayable within 23 years.

West Hartlepool.—The Corporation has decided to petition against the new Bill which the Cleveland and Durham County Electric Power Co. is bringing before Parliament.

Whitby.—The accounts of the electricity undertaking for the past year show a loss of £1,244.

Worcester.—On Friday last an inquiry was held into the application of the T.C. for a loan of £2,351 for electric light purposes.

York.—A L.G.B. inquiry has been held into the application of the T.C. for loans of £10,850 and £50,000 for extending the electricity buildings and plant. There was some slight opposition.

ELECTRIC TRACTION NOTES.

Aston.—As a result of the recent arbitration proceedings over the sale of the Birmingham and Aston Tramway Co.'s undertaking to Aston U.D.C., the shareholders will receive £9 10s. for each £5 share.

Bournemouth.—The following return has been prepared, showing the generating and running expenses of the borough tramways from the commencement of traffic to February 11th:—Generation expenses: Salaries and wages at generating station, £437 16s. 1d.; coal, £1,675 9s. 8d; engine-room stores, £40 15s. 10d.; water, £126 2s.; general insurance, &c., £60 4s. 6d.; maintenance and repairs, £10 14s. 0½d.; total, £2,351 2s. 1½d., representing 2·73d. per car-mile. Running expenses: Salaries and wages (traffic), £2,283 18s. 8½d.; car-cleaning (wages and stores), £425; car oiling (wages and stores), £98 9s. 8d.; water, £3 9s. 2d.; gas, £24 2s. 6d.; tickets, £45 17s. 3d.; punches, £24 4s. 11d.; general (rent, rates, &c.), £606 17s.; maintenance and repairs, overhead system, £96 14s. 1½d.; conduit system, £103 8s. 9d.; general, £227 1s. 2d.; total, £3,939 3s. 3d., representing 4·58d. per car-mile. The total receipts during the period in question amounted to £11,922 9s. 5½d., representing 13·86d. per car-mile; and the total expenses, as shown above, to £6,290 5s. 4½d., representing 7·31d. per car-mile; leaving a profit balance of £5,632 4s. 1d. or 6·55d. per car-mile run. Against this gross profit re-payment of loans and interest, the depreciation fund, &c., have to be reckoned. During the four weeks ending February 11th, 516,740 passengers were carried on the cars, of which number 321,234 were carried on the main route between Westbourne and Pokesdown. The amount taken in fares during the

same four weeks was £2,956 10s. 3d. The grand total of passengers carried from the commencement up to the date mentioned was 2,068,089.

Birmingham.—The tramways question here is becoming more and more interesting. The Tramways Committee had practically come to terms with Mr. Garcke and the City of Birmingham and the Birmingham and Midland Tramways Cos. for the transfer of the present leases, also for new ones to be granted to the companies. The leases were to be for 21 years, with an additional three years for, conversion, making 24 years in all. The whole of the tramways within the city were to be re-equipped on the electric overhead system without delay, the Corporation carrying out and finding the capital for the road work, and the companies finding the capital for rolling-stock and all other outlay. The Corporation to borrow its capital on the best terms that can be obtained, and the companies to pay the interest and sinking fund on such borrowing. The companies to pay by way of rent for the three years of conversion (July, 1903, to June, 1906) £12,000 per annum, and from July 1st, 1906, and afterwards until June 30th, 1911 (when the Bristol Road and cable leases fall in) 7½ per cent. of the gross receipts, with a *minimum* of £21,000 per annum. From July 1st, 1911, to the end of the lease, 15 per cent. of the gross receipts, with a *minimum* of £33,000 per annum. The rental is to run from July 1st, 1903. The Corporation to supply the electric current, except as to the Bristol Road and Dudley Road routes, at a price to be agreed upon, or to be settled by the Board of Trade in case of difference; but the Corporation has an option to take over the supply of electric current on the Dudley Road route at any time after 1906. The majority of the Committee recommended that the companies' offer should be accepted.

Before the recommendation could be considered by the Council, however, an offer from another syndicate in London was sent to the Tramways Committee by Messrs. Batten, Proffit & Scott, solicitors, of 32, Great King Street, S.W., such offer being, it is estimated, £528,000 better than that of the B E.T. organisation.

The Council met on Tuesday to consider the matter. Alderman Beale, the chairman of the Tramways Committee, said the offer on the part of Messrs. Batten & Co. had come as a bombshell, and the Committee required time to consider it, and to know who they were dealing with. Some time ago an offer was received from the same firm, but it was not worth consideration; the present terms were quite different, and could not be lightly pushed on one side. The Committee would desire to see someone connected with Messrs. Batten, Proffitt & Scott, and someone in the nature of a client, so that they might find out who he was, and who they were dealing with. Messrs. Batten had mentioned the name of Mr. Harmood Banner, of Liverpool, who, one would think, would not lend himself to a foolish offer. The Council was, of course, not able to settle the matter without further consideration, so the question stands adjourned.

Crewe.—The T.C. has appointed Mr. P. Dawson to advise it on the draft prov. order and agreement in connection with the proposed electric trams, submitted by Messrs. Hewitt and Rhodes, of Manchester.

Electric Railways in U.S.A.—A report from Laporte, Indiana, an important railroad centre, states that the first serious step towards long-distance electric traction in the United States is a scheme to connect New York and Chicago with an electrically-propelled railroad, the Hobart and Western Electrical Co., of Chicago, having negotiated for the right-of-way between Laporte and South Bend. A similar right-of-way system between South Bend and Michigan City has been acquired by a syndicate in which Senator Hanna's family is largely interested, there being a further plan to connect Chicago with Cleveland, Ohio. As a practical piece of electrical railroad engineering, however, the New York Central Railroad is altering so much of its track as is on Manhattan Island, about four miles in length, for electric traction, so that no steam locomotives may come into the heart of New York City.

Exeter.—The poll on the electric tramways Bill of the Corporation has resulted in a majority of 3,986 in favour of the Bill. The figures are—for the Bill, 7,581; against, 3,595.

Glasgow.—The general manager of the Corporation tramways has been authorised to advertise for tenders for the construction or extension of the system from Union Place corner to Cambuslang, and from Crookston to Hawkhead Road, Paisley.

Gloucester.—The County Council has offered to lease for a term of 30 years to the T.C. the powers recently granted for a light railway from the city to Barnwood and Hucclecote, at a rent equal to the interest and sinking fund on the cost of construction; the Corporation to bear the cost of maintaining the line, and provide the electrical equipment, cars, &c. The Corporation Tramways Committee has recommended the Council not to entertain the offer.

Huddersfield.—Mr. H. N. Thomas, the engineer and manager of Huddersfield Corporation Tramways, reported to the Tramways Committee at their monthly meeting that during the month of February 189,060 units had been generated at the power house, at a cost of ·261d. per unit, or, including maintenance of plant, ·306d. per unit. During the month of February 110,203 car-miles have been run and 790,665 passengers carried.

Italy.—Messrs. Woodhouse & Baillie, by a decree of the Prefect of the Province of Porto Maurizio, dated February 16th, 1903, have been granted a concession to derive 1,300 H.P. from the River Roya. Part of the power will be used to extend the present Ventimiglia-Bordighera electric tramway (which was described in our columns some time ago) to Mentone on the west, and to San Remo on the east, concessions for which extensions are already held by Messrs. Woodhouse & Baillie. The part of the River Roya referred to in the concession is distant eight miles from Ventimiglia, where the river makes a considerable loop upon itself, and by means of a tunnel only 100 metres long a fall of over 60 ft. is obtained. The expense of development will thus be exceptionally low, and is estimated at not more than £2 per H.P. for the whole of the hydraulic work. The balance of the power not required for the tramway will be utilised in further extending the electric supply undertaking in the towns of Ventimiglia, Bordighera, and San Remo, the last mentioned in conjunction with the British Continental Electricity Co., Ltd.

Liverpool.—On December 31st, 1902, the Corporation's stock of cars, numbering 488 in all, comprised the following classes:—15 single-deck motor-cars, with trailers, of German make; 12 single-deck cars of American type, with side entrance; 3 American cars, with upper decks and reversed staircases; 114 double-deck single-truck motor-cars, with ordinary type of staircase; 313 double-deck single-truck motor-cars, with reversed staircases; 31 double-deck single-truck motor-cars, with reversed staircases, and fitted with canopy tops. During the past year 30 new cars of standard pattern were obtained from Messrs. Dick, Kerr & Co., Ltd.

London County Council.—The Council at the meeting on Tuesday received a report from the Parliamentary Committee on the subject of the underground railway Bills of the present session. The report mentioned that it was not proposed to postpone the consideration before Parliament of the Charing Cross, Euston and Hampstead Bill, the Great Northern, Piccadilly and Brompton Bill, the Baker Street and Waterloo Bill, and the City and North-East Suburban Electric Railway Bill. In the opinion of the Committee, however, all the Bills should be postponed, and they had, therefore, asked the President of the Board of Trade to receive a deputation in order to urge the adoption of that course; but the application was refused.

The following notice of motion stands in the name of Mr. M. Beachcroft, to be seconded by Mr. Sidney Low:—

That it be an instruction to the Highways Committee to report—(1) As to the cost of construction per mile of single track (exclusive of cars and power stations) of a tramway on the overhead system as compared with the conduit; (2) As to the saving, if any, in working expenses and time occupied in construction, in the one system as compared with the other; (3) As to the objections, if any, to a mixed system of overhead and underground traction, and the practicability of an exchange between the two systems; (4) Whether, inasmuch as the overhead system will inevitably prevail outside the County of London, there is any solid reason why the Council should not adopt the overhead system inside the county in those districts which are sufficiently removed from the crowded centre of London and where the local authorities concerned do not object.

Manchester.—The new electric tramcar service to Openshaw is to commence running on the 1st prox. This length of tramway will form a part of the Manchester and Ashton-under-Lyne service ultimately. The connection between the city and borough is expected to be completed in a month or two. During the past week the Corporation was able to open the tramway service between the city and Old Trafford, in the Stretford district. The line now working is a part, the completion of which was delayed owing to legal proceedings between the Stretford District Council and the Manchester Carriage Co.

Mombasa.—Notice is given that the Government tram line in the island of Mombasa has been leased to Mr. A. G. Anderson for a period of three years. *A propos* a local paper says: "It is quite possible that a small electric plant will be erected in Mombasa this year, in which case the line will be worked by electricity."

New York Subway.—While our own Royal Commission is engaged on the question of traffic problems, it is of interest to note the action just taken by the Rapid Transit Commission of New York. It has awarded the contract for the entire control equipment for the New York Underground Railways to the General Electric Co., of Schenectady. The system to be used is the electrically-controlled multiple-unit system, which is the same as that installed upon the trains of the Great Northern and City Railway, the experimental trains on the Central London Railway, and also on the North-Eastern Railway, near Newcastle, which is to be equipped upon this system by the British Thomson-Houston Co., Ltd., of Rugby. This contract for the multiple-unit system was awarded only after thorough examination and severe competitive tests of different systems. This system of multiple-unit train control is described in the B.T.H. Co.'s No. 139 pamphlet issued last month.

Newcastle-on-Tyne.—The Tramways Committee recommends that application be made to the B. of T. for sanction to loans amounting to £128,269 for purposes in excess of the £340,847 already sanctioned. The chief items in the schedule are included under the following heads:—Street widenings, £19,721; land for power station, £6,116; construction of Gosforth tramways, £10,718; fees, £5,800; offices, &c., during construction, £1,806; legal charges, £3,709; cables, &c., in streets, £1,533; expenses in connection with power station, £11,265; accumulators, £4,755; expenses connected with car sheds, £23,655; and cars, £4,033; erection of power station, £6,273.

Newport (Mon.).—A trial trip of one of the new cars has been made over a portion of the system. The lines will be opened in April.

Paisley.—Mr. Wm. Murphy expects to have his electric tramway system completed between Hawkhead Road, Paisley, and Johnstone during the summer, and to have the line from Paisley Cross to Renfrew finished before the end of the year.

Rochester.—The T.C. has agreed to lease its electric tramways to the Chatham and District Light Railways Co. The company is to maintain the rails and overhead equipment, and pay the Corporation the amount of the sinking fund and interest upon the actual cost of the system, together with £600 a year towards the repair of roads.

Salford.—Some excitement has been aroused by the action of the Tramways Committee in connection with the tenders for the supply of 50 electric tramcars. After rejecting the British Westinghouse Co.'s tender as not in accordance with the specifications, the Committee recommended that the order be placed with the British Thomson-Houston Co., Ltd., who sent in the lowest tender, with 40 Milnes and 10 British Electric Car Co.'s car bodies. The Council referred the matter back to the Committee, with a view to all the car bodies being made by the local company, but in the later recommendation of the Committee, it was found that the tender of the British Westinghouse Co., Ltd, had been substituted for the one previously accepted. At the Council meeting on the 4th inst., a prolonged and animated discussion took place, many members protesting against the change. It appeared that there had been some misapprehension as to the terms of the tenders, and it was suggested that there had been a revision of the tender last accepted. The Council passed the recommendation by 20 votes to 17, but notice was immediately given to call a special meeting to reopen the question. This took place on Wednesday last, when the decision of the Council was confirmed.

We can only say that, if any alteration of any of the tenders was permitted after the tenders had been opened, the action of the Tramways Committee was dishonourable, and it is highly desirable that even the semblance of such occurrences should be avoided.

The electric tramway service to and from Swinton was inaugurated on Saturday last. A regular 10 minutes' service has been established.

Southampton.—Extensions are to be made to the tramway switchboard at a cost of £359, which is to be debited against revenue account for the current year.

The Tramways Committee has recommended that the sum of £5,000 out of the past year's profits be devoted to the reduction of the rates.

Stretford.—The District Council has agreed not to oppose the Southern Tramways Bill, and the Manchester Corporation will take a lease of the tramways.

Swansea.—The electric equipment of the Swansea and Mumbles Light Railway cannot, it is officially announced, be accomplished at present, owing to the refusal of the Swansea Corporation to grant passing places near the Recreation Ground.

West Bromwich.—The remaining portion of the tramway system—the Hill Top section—is to be opened in the course of a few days.

Wolverhampton.—The following curious resolution was passed at the meeting of the Town Council on Monday:—"That, under the special circumstances stated in the Lorain Steel Co.'s letter, dated February 20th, 1903, a written contract with the company for the supply of these fittings be dispensed with, and that the resolution of the Council passed on February 9th, 1903, be varied accordingly." The contents of the letter referred to have not been disclosed.

TELEGRAPH AND TELEPHONE NOTES.

Glasgow Telephones.—The Secretary for Scotland has consented to the borrowing by the Corporation of a further sum of £80,000 to defray capital expenditure under the telephone license, raising the total sum authorised to £300,000. This consent is given in reliance on the offer of the Corporation to make such arrangements, by setting up a reserve fund or otherwise, as will prevent the reasonable possibility of the ratepayers being called upon at a future date to pay off a debt contracted in providing—at a price which, if this course is not taken, would be under cost price—a service which is used by a comparatively limited proportion of the community.

It is stated that the Telephone Committee has had a conference with representatives from the local authorities of Airdrie, Coatbridge, Motherwell and Wishaw, and the District Committee of the Middle Ward of Lanarkshire with reference to the establishment of a telephone system in the locality in connection with the Glasgow Corporation system.

International Telegraph Conference.—The Postmaster-General has appointed the following delegates to represent Great Britain at the International Telegraph Conference to be held in London at the end of May:—Mr. J. C. Lamb, Second Secretary to the Post Office; Mr. John Ardron, Assistant Secretary; Mr. P. Benton, Assistant Accountant-General; Mr. R. J. Mackay, Secretary's Office; and Mr. F. W. Home, Accountant-General's Department. The arrangements for the reception and entertainment of the foreign and colonial delegates have been entrusted to a committee, of which Mr. G. W. Smyth is the chairman.

A contemporary says that Mr. F. Hansen, Argentine Consul in Liverpool, has been chosen to represent Argentina at the Telegraphic Conference.

The Pacific Cable.—A telegraph dispatch dated Ottawa, March 6th, says that information has reached the Government of Canada to the effect that the Government of the Australian Commonwealth proposes to grant extensions of the facilities accorded to the Eastern Extension Cable Co. in the States of Victoria and Queensland. The Canadian Government looks upon this as a violation of the arrangement entered upon for the construction of the Pacific Cable, and will make a very strong protest against any such arrangement as that proposed.

Telegraphic Communication with Iceland and Faroe.—A deputation waited on the Postmaster-General a few days ago to urge upon him the necessity for establishing telegraphic communication with Iceland and the Faroe Islands. Mr. Doughty said it would not be an expensive or difficult thing to lay a cable from a point in Scotland to the Faroe Islands, a distance of 205 miles, and from those islands to a point on the coast of Iceland, a distance of about 278 miles. Since Mr. Marconi seemed to have done so much by wireless telegraphy, he thought that, perhaps, the Post Office might be willing to give the system a trial instead of laying a cable.—Mr. Henniker Heaton also put in a plea for Marconi's system of wireless telegraphy. He understood, he said, that the Marconi Co. were willing to establish wireless communication at a tenth of the cost of any system of cables.—Mr. A. Chamberlain, in reply, said that he was not without hope that if telegraphic communication with these islands was of such importance, it would become possible in a short time for the Great Northern Telegraph Co. to proceed with its original intentions in the matter, or, failing that company, for some one else to take up the task. Mr. Heaton had raised a point which seemed to counteract any proposal that they should immediately subsidise a system to the Faroe Islands and Iceland. Mr. Heaton had assured them that one of the wireless systems now being brought to perfection was already in a position to do this work at one-tenth of the cost by a cable company. The subject of wireless telegraphy and the relations of those who carried it on with his Majesty's Government were now the subject of most careful consideration by the different Departments concerned. He was receiving from different inventors or holders of the patent rights of different inventions applications for licenses to carry on wireless telegraphy in different parts of the country, each of which must be treated on its merits, and in regard to all of which he hoped the Government would soon be able to lay down some general rules which would have to be observed. At the present time it was open to any persons to establish a station on our coasts for the transmission of wireless messages, provided they did not use it for communication within the three-mile limit or within the United Kingdom. So far as he was concerned, it was his desire not to impose unnecessary restrictions nor hamper needlessly the operations of any cable and wireless company taking up the work.

The Tasmanian Cable.—We learn from the *Melbourne Age* that the Federal Government has entered upon definite negotiations with the Eastern Extension Telegraph Co. for the purchase, at a cost of between £200,000 and £300,000, of the submarine cable between Victoria and Tasmania. For the present the Prime Minister does not care to reveal the entire conditions of the purchase. The company suggested a certain price, and departmental officers of the Post Office are now making valuations.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Trinidad-Demerara No. 1	Aug. 27, 1900	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Guadeloupe-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Nov. 18, 1902	
Martinique-Puerto Plata	July 10, 1902	
Guantanamo-Mole St. Nicholas	Aug. 4, 1902	
Cayenne-Pinheiros	Aug. 13, 1902	
Reissi-Issa-Reissi-Yemani	Oct. 22, 1902	
Cadiz-Teneriffe	Nov. 8, 1902	March 5
St. Jacques-Haiphong	Jan. 3, 1903	
Jamaica-Colon	Dec. 31, 1902	
Paramaribo-Cayenne	Feb. 23, 1903	
Trinidad-Demerara No. 2	Feb. 27, 1903	
Zanzibar-Mombassa	March 7, 1903	
Landlines:—		
Route to Tientsin and Taku *via* Helampo	June 18, 1900	
Communication with Honduras-Central America	Feb. 26, 1903	

Underground Cables.—Mr Austen Chamberlain (Postmaster-General) received at the House of Commons on 5th inst. a deputation from chambers of commerce and others who urged that underground cables should be extended from London to Scotland, that system only existing between London and Birmingham at present. Mr. Austen Chamberlain, in reply, said that by the end of the financial year (March 31st) they would have a completed cable from London to Birmingham, carrying 76 wires, thence forward to Stafford, from Stafford to Warrington by temporary wires drawn in, and thence an unbroken communication with Manchester, Liverpool and Chester. Further north, pipes were laid a distance of 30 miles between Preston and Preston Richard, and 16 miles between Kendal and Shap. He proposed to ask the House of Commons next year to agree to the expenditure of £131,000; with this it was proposed to complete the pipes to Carlisle, filling in Warrington to Preston, 31 miles, Preston Richard to Kendal, seven

miles, Shap to Carlisle, 21 miles; and it was proposed to carry the lines from Manchester *vid* Bradford to Leeds, a distance of 50 miles. That would form a link in what he hoped would be a further development in later years which would serve all the towns on the north-east coast, Newcastle, and others, and at the same time safeguard the communication with Hull. It was also proposed to provide a full-sized cable in the Birmingham—Warrington section. At the present time it was only filled with temporary wires, and it was proposed to use the temporary wires thus released on the Warrington and Kendal section and lay fresh temporary lines in anticipation of the preparation of the permanent cable between Leeds and Manchester. As to Scotland, it was proposed to begin the work for the London and Edinburgh line on the Beattock incline, a distance of 19 miles, as the beginning of the work from the northern end.

Wireless Telegraphy.—On 5th inst. Monsignor Molloy lectured on "The Principle of Musical Sympathy and its Application to Wireless Telegraphy" at the University College, Dublin.

Speaking at the annual meeting of the Governors of the Royal National Life-boat Institution on 5th inst., Mr. Gerald Balfour said that the need of wireless telegraphic communication with the coasts had already been brought before his attention a great many times, and was constantly in his mind. Hitherto the matter had not been entirely free from difficulty, partly owing to the nature of wireless telegraphy and partly to the novelty of the invention. Its bearings on the problems of national defence and the private interests connected with it had made it necessary to deal with the subject comprehensively. This was the reason of the delay. The Board of Trade was by no means oblivious to the advantages of connecting the shores with the lighthouses by this means, and he trusted it would not be very long before the Fastnet Lighthouse was connected with the shore, and also the Goodwin Sands Lightship.—Sir R. Penrose Fitzgerald, M.P., said Mr. Balfour had spoken of connecting the Fastnet Lighthouse with the mainland by means of wireless telegraphy. Only on Wednesday night he (Sir Robert) had spoken to the man in charge of the Marconi box at Roche's Point Lighthouse, who told him that it was impossible to get the Marconi system to work within 20 miles of Crookhaven, owing to the metallic nature of the rocks at Crookhaven. He trusted that the Board of Trade would remember this before it went to any great expense in connecting the Fastnet and the mainland by wireless telegraphy.—The resolution was carried, and the proceedings closed with a vote of thanks to the Chairman.

It is announced that the Post Office authorities have acceded to Signor Marconi's request to connect the wireless telegraph station at Poldhu, Cornwall, with the nearest postal telegraph station, so that continuous through communication will now be assured. Instructions have already been given for the connecting wire to be erected.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 14th. Twelve double-deck tramcars. See "Official Notices" February 27th.

Barking.—March 20th. Overhead equipment, poles, feeder cables, &c. See "Official Notices" February 13th.

Barrow-in-Furness.—March 25th. Cable and conduits. See "Official Notices" to-day.

Bedford.—March 23rd. High and low-pressure cables. See "Official Notices" to-day.

Belgium.—March 18th. The Belgian State Railway Authorities at La Bourse, Brussels, want tenders for the supply of a switchboard and transformers for the central electric lighting station at Berchem, near Antwerp.

Belgium.—April 11th. Tenders for the Municipal Authorities of Liège, for the installation of a complete electric lighting plant at the Theatre Royal, Liège. Tenders to L'Annexe de l'Hotel de Ville, Liège, whence full particulars may be obtained for 30 francs.

Bilston.—March 16th. Wiring and fittings for public buildings. See "Official Notices" February 20th.

Blackburn.—March 23rd. Stores, incandescent lamps, meters, cables, arc lamp carbons, joint boxes, switches, fittings, &c., for 12 months. See "Official Notices" March 6th.

Brussels.—March 25th. At the Brussels Bourse for account of Belgian State Railway: supply of sundry objects for the use of the electric installations department, in eight lots. Particulars from the offices, 76, Rue Belliard, Brussels.

Bury.—March 30th. The Electricity Committee invite tenders for the following plant:—Section C, boilers and other ironwork; Section D, superheaters; Section E, economisers.

Darlington.—March 20th. Eight double-deck and eight single-deck tramcars, with equipment. See "Official Notices" February 27th.

Denmark.—March 31st. Copenhagen Public Lighting Department wants tenders for the supply of five water-tube boilers of 300 sq. metres heating surface capacity each. Particulars from the Copenhagen Belysningsvaesen, Vestre Boulevard, Copenhagen.

Edinburgh.—March 16th. Telephone installation at Clinton Mains Hospital. See "Official Notices" February 27th.

Fulham.—March 30th. Mains for electric lighting. See "Official Notices" to-day.

Gillingham.—March 30th. 500 tons coal, oil, and electricity meters. See "Official Notices" to-day.

Heckmondwike.—March 20th. 250-KW. steam generator with piping; feeder and connections. See "Official Notices" March 6th.

Hornsey.—March 16th. Cables and stores. See "Official Notices" February 27th.

Hungary.—March 15th. Tenders are being invited until the 15th inst. by the municipal authorities of Raab for the establishment of a central electric lighting station in the town.

Ilford.—March 24th. Electricity meters, fuse boxes, incandescent lamps, cables, stores, &c. See "Official Notices" to-day.

L.C.C. — March 17th. 200 tramcars, complete with trucks, motors, controllers, &c. (100 bogie and 100 single truck). See "Official Notices" February 20th.

L.C.C.—March 24th. Traction switchboards to be erected at Deptford. See "Official Notices" February 27th.

Leek.—April 3rd. Two gas engines, two 60-KW. dynamos, cooling tanks, pipes, &c.; stoneware casings, cable work, &c. See "Official Notices" to-day.

Londonderry.—April 24th. Lancashire boilers, pipework, pumps, &c., steam dynamos, boosters, battery, switchboard, crane, conduits, cables, &c. See "Official Notices" to-day.

Lowestoft.—April 8th. Dry-back boiler and superheater, pump and accessories; piping, &c.; condenser, pumps and cooling tower; 500-KW. steam dynamo, &c.; switchboard. See "Official Notices" to-day.

Madrid.—March 23rd. At the Postal and Telegraph Department, Madrid; supply of 40,000 insulators in porcelain. Estimate 40,000 pesetas.

Plymouth.—March 15th. Meters, transformers and cables. See "Official Notices" February 27th.

Rangoon.—July 1st. The Municipal Committee wants tenders for carrying out its electric lighting license, and particulars, forms, &c., can be obtained from the officiating secretary (W. Shircore), Rangoon municipality, at Rs. 75 per set.

Rhyl.—March 16th. Carbons and meters. See "Official Notices" February 27th.

Rotherham.—March 24th. 15 double-deck cars. See "Official Notices" to-day.

Salford.—March 14th. Cables, meters, fittings, carbons, motors, conduits, stores, &c., for 12 months. See "Official Notices" February 27th.

Sheffield.—March 23rd. 100 car wheels and 400 steel tires. See "Official Notices" to-day.

Shipley.—March 16th. Traction storage battery. See "Official Notices" March 6th.

Spain.—March 23rd. The Spanish Post and Telegraph Authorities in Madrid are inviting tenders until the 23rd inst. for the supply of 40,000 porcelain insulators. Particulars may be obtained from, and tenders are to be sent to, La Direccion Général de Correos y Telegrafos, Carretas, 10, Madrid.

St. Pancras.—March 24th. 47 miles lead-covered and armoured cable. See "Official Notices" March 6th.

Stretford.—March 27th. Switchboards, &c.; battery, booster, &c.; motor-generators; meters. See "Official Notices" to-day.

Sunderland.—March 27th. Annual supply of I.R. covered cables and stoneware casings; one fuel economiser. See "Official Notices" February 27th.

Sunderland.—March 27th. Two Lancashire boilers. See "Official Notices" March 6th.

Swindon.—March 24th. Switches, incandescent lamps, boxes, &c., for adapting 90 street lamp columns for electric lighting. See "Official Notices" March 6th.

Sydney.—April 15th. Telegraph, telephone, and electric light material for the Departmental Stores (Postal).

Watford.—About 2,500 tons (12 months' supply) of coal for chain grate stokers. See "Official Notices" March 6th.

Walthamstow.—April 4th. Free wiring. See "Official Notices" to-day.

Wednesbury.—March 28th. Motor-generators, boosters, accumulators, switchboards, cables, &c., and street work, meters, indicators, fuses, &c. See "Official Notices" February 27th.

Wrexham.—March 21st. Stores, cables, joint boxes, &c., meters, incandescent lamps, carbons, &c. See "Official Notices" March 6th.

CLOSED.

Admiralty.—The Lords of the Admiralty have accepted the tender of Messrs. Veritys, Ltd., for pressure fans coupled direct to motors, at £723.

Batley.—The T.C. has accepted the following tenders for supplies to the electricity works and tramways:—Callender's Co., for tramway and lighting feeders; Mr. E. M. Evans, Manchester, for station lighting, &c; the British Insulated and Helsby Cables, Ltd., for overhead equipment; Messrs. J. G. Statter & Co., for lighting and traction switchboard.

Barrow-in-Furness.—Messrs. Dick, Kerr have sublet the contract for two 450-H.P. compound Willans engines for direct coupling to their dynamos.

Bradford.—Messrs. Edmondson & Purdom, Ltd., of Albert Electrical Works, Bradford, have received an order from the City Tramways Committee for 50 patent automatic time recorders for fixing on the various routes. The Sheffield Corporation Tramways Committee has also given them an order for a pair of Edmondson's automatic locking signals for a single-track section of their system.

Brighton.—On March 7th the T.C. accepted the tender of the Ericsson Bell Telephone Co., Ltd., to supply and fit up the special Post Office trunk line board required in connection with the municipal telephone system, and to supply and lay cables from the switchboard to the test room, at £150.

Buckingham.—The T.C. has accepted the tender of Messrs. Gillies & Hornidge to supply current to the public electric lamps till May 31st next.

Cardiff.—Messrs. Musgrave & Sons' tender has been accepted for the supply of five Lancashire boilers for the electrical works, at £6,153.

Darlington.—The T.C. on March 5th accepted the following tenders in connection with the electric tramways:—Messrs. R. Taylor & Sons, for boilers at £630; Messrs. Bertram, Ltd., for extension pipe work at £922; Messrs. W. T. Glover & Co., for tramway feeders at £2,257; Messrs. J. G. White & Co., Ltd., for permanent way (Bolckow, Vaughan & Co.'s rails, and Atkinson and Co.'s points and crossings) at £37,624.

Grantham.—The T.C. on March 4th accepted the tender of Messrs. Manlove, Alliott & Co., Ltd., for the erection of a refuse destructor at £2,530.

Great Yarmouth.—Messrs. Mather & Platt, Ltd., have sublet the contract for one 600-H.P. compound Willans engine for direct coupling to one of their alternators.

Isle of Man.—Messrs. Kincaid, Waller, Manville and Dawson, the consulting engineers to the Manx Electric Railways Co., Ltd., have recently placed an order with Messrs. Witting Bros, Electrical Engineers & Contractors, Ltd., London, for the complete re-equipment of the line in an up-to-date manner. The order includes two 300-KW., 7,000-volt, 25-cycle, three-phase generators (with exciters), directly coupled to triple-expansion Belliss engines, transformers to the extent of 900 KW., six rotary converters of 150 KW. each, one three-phase 7,000-volt induction motor of 80 B H.P., four high-pressure switchboards, four traction switchboards, 13 four-motor car equipments complete, together with accessories and spare parts for the whole of the above. At present these lines are worked from a number of separate generating stations, and the above re-equipment is considered certain to result in an increased economy in working.

London.—The L.C.C. has accepted the tender of the St. Helens Cable Co., amounting to £380, for laying a cable from the generating station on the Victoria Embankment for supplying the lamps on Waterloo Bridge. The following tenders have been received for the supply of high and low-pressure, and exciter switchboards required for the three tramway sub-stations at the Elephant and Castle, New Cross and Camberwell respectively:—

J. G. Statter & Co.	£5,291
British Westinghouse Co. (accepted)	5,367
Cox-Walkers	5,972
Cowans, Ltd.	7,100
Electric Construction Co.	7,595
" " " (alternative tender)	9,140
" " "	9,940
Siemens Bros. & Co.	8,092
General Electric Co.	10,885

Tenders were also received from other firms for portions of the contract, but it was not considered advisable to divide the work.

Exeter.—The E.L. Committee has accepted the tender of Messrs. Siemens Bros. & Co., for electric cables, at £2,450.

Liverpool.—The tenders of the following firms have been accepted for yearly supplies to the Electric Tramway Department by the T.C.:—Messrs. G. McLellan & Co.; Liverpool Electric Cable Co., Ltd.; St. Helens Cable Co., Ltd.: Western Electric Co., Ltd.

The following have received contracts for the supply of materials to the electricity works:—A. & R. Brown & Co.; R. Roberts & Sons; Perrin, Hughes & Co.; P. Lloyd, Jones & Co.; Edison & Swan Electric Light Co., Ltd.; Liverpool Electric Cable Co, Ltd.; British Insulated and Helsby Cable Co, Ltd.; S. Z. de Ferranti, Ltd., Hollinwood; Mr. J. Cookson, Manchester; Mr. R Lambert, Bradford; Lancashire Wood Working Co., Ltd., Preston; Mr. Fabius Henrion, Nancy; Wm. McGeoch and Co., Ltd., Birmingham; General Electric Co, Ltd., Manchester.

Newport.—The Corporation on Tuesday sealed tenders in connection with their new asylum as follows:—Messrs. Lowden Bros. & Co., for wiring and fitting £2,500; Bertram Thomas, for generating plant £3,433; Electric Construction Co., for balancing machine £134 5s.; Messrs. Blackwell, for tower wagon £75.

Salford.—The Council has adopted a recommendation of the Tramways Committee to accept the tender of the British Westinghouse Co., Ltd., Manchester, to supply 50 cars at £734 6s. each, subject to 20 of the car bodies being built by the British Electric Car Co., Trafford Park, and 30 by Messrs. G. F. Milnes, Hadley.

Stoke-on-Trent.—Messrs. Dick, Kerr & Co. have sublet the contracts for two 250-H.P. compound Willans engines for direct coupling to their dynamos.

West Ham.—The Council on 10th inst. accepted the following tenders:—

Overhead equipment	Macartney, McElroy & Co., Ltd.
Accumulators	Tudor Accumulator Co., Ltd.
Purifier	Harris Patent Feed Water Filter, Ltd.
Cable, boxes, &c.	British Insulated & Helsby Cables, Ltd.
House cut-out boxes	Reason Manufacturing Co.
Engine-room stores	Wiggins & Rihll.
Meters	Geipel & Lange.
Transformers	British Electric Transformer Co.
Incandescent lamps	Cryselco Co., Ltd.

FORTHCOMING EVENTS.

Friday March 13th.—At 8 p.m. Institution of Electrical Engineers (Dublin). "Development of Electrical Energy Supplies," by Mark Ruddle.

Saturday, March 14th.—7 to 11.30 p.m. Junior Institution of Engineers. Annual conversazione at the Westminster Palace Hotel.

Monday, March 16th.—At 7.30 p.m. I.E.E. (Newcastle). Discussion on H. L. Riseley's paper; J. P. Sleigh on "Notes on Mechanical Details of Enclosed Arc Lamps."

At 8 p.m Inst. of Marine Engineers. Paper on "Fuel Testing Experiments."

At 8 p.m. Society of Arts. Cantor Lecture II., by Prof. J. A. Fleming, on "Hertzian Wave Telegraphy in Theory and Practice."

Tuesday, March 17th.—I.E.E. (Manchester). W. A. Price on "The Use of the Potentiometer in Furnace Gases."

Wednesday, March 18th.—At 2.30 p.m. Institution of Civil Engineers. Students' visit to the generating station of the Central Electric Supply Co., Ltd., Lodge Place, N.W.

Thursday, March 19th.—Edinburgh Students' Engineering Society. Prof. Baily on "New Developments of Electric Traction."

At 7 p.m. Annual Dinner of the London Electrical Contractors' Association at Holborn Restaurant.

Saturday, March 21st.—At 3 p.m. Royal Institution. Lord Rayleigh on "Light: Its Origin and Nature." (Lecture IV.)

Association of Engineers-in-Charge. Annual Dinner.

At 7.30 p.m. Glasgow Technical College Scientific Society. R. Baillie on "Stirling Water-Tube Boilers."

NOTES.

Automobile Exhibition.—The eighth of Messrs. Cordingley's motor-car exhibitions at the Agricultural Hall, Islington, is to be held from March 21st to 28th, under the auspices of the Automobile Mutual Protection Association. There are to be nearly 300 exhibitors, and practically all the well-known types will be represented.

Accident.—While erecting a new telephone wire at Glasgow, a telephone employé was shocked through the wire coming into contact with the tramway conductor. He fell to the ground (26 ft.) and sustained serious injuries.

National Electrical Contractors' Association.—The annual general meeting of this Association was held in Anderton's Hotel, E.C., on 2nd inst, when a large and representative attendance from different parts of the United Kingdom was present. Mr. W. R. Rawlings, President of the Association, presided. Reports were submitted by the secretaries of the Metropolitan and Provincial Associations, which showed that all sections of the Association were progressing satisfactorily. The President referred to the good work that had been done by the Central Board during the year in opposing measures promoted by local authorities and the London County Council, with obnoxious clauses asking for powers that encroach on the business of the electrical contractor. He stated that their efforts had met with some measure of success, and that the board were keeping a strict outlook on all such Bills. He also referred to the valuable assistance that had been rendered to the Association by the honorary counsel, Mr. M. O'Sullivan, Temple, and the honorary solicitors, Messrs. Turner & Co., of 61, Carey Street, W.C. He stated that the board were still conferring with a Committee of the Manufacturers' Association, and trusted shortly to be able to arrive at an understanding with them which would be mutually advantageous to all parties. The President informed the meeting that at this stage he could not give any details of the conference with the manufacturers, but he pointed out that the Association would benefit to a material extent, and all contractors who desire such advantage should join the Association without delay. Mr. Tweedy Smith (of Messrs. Turner & Co.) addressed the meeting at some length on the question of municipal trading. He also desired the members present to sign the petition which his firm had drawn up in opposition to the objectionable clauses in the London County Council Bill which was being opposed by the London Association. Mr. Duncan brought under the notice of the meeting a system of registration of workmen which is being introduced by the London Association, and a discussion and comparison with a similar system in use by the Northern Section of the Association, followed. The following gentlemen were appointed officers for the ensuing year:—

President—Mr. W. R. Rawlings, London.
Vice-Presidents—Messrs. A. E. Porte, Dublin; J. McDermott, Ashton-under-Lyne; W. W. Strode, London; C. L. Troup, London; T. Wright, Glasgow; H. Bland, Newcastle-on-Tyne; C. Rawlings, London; W. E. Duncan, London; W. R. Woodward, London; W. W. Gillard, London; W. Cross, Newcastle-on-Tyne; E. C. Wallis, Leeds.
Honorary Treasurer—Mr. H. Marryat, 28, Hatton Garden, E.C.
Secretary—Mr. Thos. Guthrie, chartered accountant, 46, Queen Victoria Street, E.C.
The Central Board will consist of these officers and other members to be elected forthwith by the Metropolitan and Provincial Associations from their members.

B.E.T. Club.—On Friday evening the 6th inst. this enterprising club held its first Bohemian Concert in the Grand Hall of the Freemasons' Tavern, Great Queen Street. The evening proved an unqualified success and the hall was full. Mr. J. S. Raworth occupied the chair during the first half of the concert, and as is his custom, aroused much merriment by the felicitous speeches in which he proposed the time-honoured toasts of "The King" and "The Ladies"; to the first the audience responded by singing the first verse of the National Anthem, and Mr. George Cornwallis-West replied on behalf of the ladies. The programme was very varied, comprising both instrumental and vocal music together with humorous sketches, and all the turns were well rendered by leading artists in their respective branches. We were particularly struck by the singing of Miss Emily Carter, Mr. Leo Wilson, and Mr. Clifford Constable, and by the excellent sketches and songs given by Miss Jessie Jolly, Mr. Charles Nott, and Mr. Wilfred Stracey. Mr. Charles Newman's banjo pieces were highly appreciated, as were the pianoforte solos of Mr. Percy Taylor, who also acted as accompanist. During the second half Mr. C. S. B. Hilton acted as chairman, and on the conclusion of the concert shortly after 11 o'clock, a hearty vote of thanks was passed both to him and to Mr. Raworth; this was followed by the National Anthem, and the assembly then broke up.

I.E.E. Manchester Section: Annual Dinner.—This event took place at the Grand Hotel, Manchester, on Friday, March 6th. Mr. H. A. Earle, chairman of the Section, presided over a large company.

Following the toast of "The King," Dr. Edward Hopkinson proposed "The Institution of Electrical Engineers." He said there existed in Manchester some years ago a Northern Society of Electrical Engineers; that Society had a large membership amongst those engaged in the engineering industries in the North of England, but for some reason or other its career was not one of progress, but of decline. That society had amalgamated with the I.E.E. of London, becoming the first "local Section," and the membership since had very largely increased. To-day they had approaching 500 members and amongst them 75 students. With two exceptions, Manchester was the largest producer of electricity in the kingdom. The citizens had invested large sums of money in connection with the lighting and tramway undertakings, and it was on the principles of the science upon which such undertakings were founded and conducted that they in the local Section chiefly interested themselves. With regard to the Electricity Department of the city, he believed that, having found the means of supply, the demand would soon come. He had not the least doubt that in a few years they would be able to look back with feelings of intense satisfaction upon the action of the Electricity Committee of the Corporation and its engineer in providing for the developments that were sure to take place in the next few years; as in the case of the School of Technology, so it would be with the electrical undertaking of the city. The chairman, responding, regretted the unavoidable absence of Mr. Swinburne, who had expected to be present. With regard to electricity, they were lost in speculation as to where it might lead them. Mr. Earle drew attention to the importance of Manchester as a centre of electrical industry, and to the facilities afforded for electrical training. He trusted the scheme for providing central premises for the scientific societies of the city would soon reach some practical stage which would not only benefit the members of these societies, but also the whole community.

Mr. W. P. Fawcus proposed "Our Guests." Unjustifiable attacks, he observed, had been made upon one of their members in respect of the Corporation electricity supply. He agreed with Dr. Hopkinson that the time would come when the Manchester public would thank the officials for the steps they had taken. The Lord Mayor of Manchester responded. The Corporation, he said, had spent a vast amount of money on electrical equipment. He began to think they had gone a little to far, but the remarks of Dr. Hopkinson and other gentlemen were somewhat encouraging. Manchester could afford to risk something, but he doubted whether the Corporation ought to risk very much. They were called upon to see their way pretty plainly in the investment of capital. Electrical engineers had had much to contend with; a few years ago all thought electricity would undoubtedly establish itself for lighting, but gas had made such great strides that it seemed the fashion now to adopt the superior gas systems for street lighting. He looked forward to the supply of electricity for power, and believed it would do much to diminish the awful cloud of smoke that always hung over our manufacturing towns and cities. Mr. Wicksteed also responded in a short but admirable after-dinner speech. Electrical engineers were doing much to dispel the darkness and blackness of the towns; they were also crushing the demon of cheapness, and showing that convenience and efficiency were more important factors than first cost. He appreciated the honour to the Institution of Mechanical Engineers that he had been invited to be present, and humorously noted that as this section was a child of the parent Institution, he must be its uncle, and was glad they had "made room for their uncle."

Mr. S. Z. de Ferranti proposed "The Manchester Technical and Scientific Societies." He pointed out the importance of these societies in enabling those who had left the colleges to keep pace with the rapid advancement of the times, which, without their aid and that of the excellent literature of the technical press, it would be impossible to do. They were honoured by the presence of the chairman of the Technical Instruction Committee, and he must say that though he had visited many technical and other colleges in different countries, he had not seen one equipped so completely as the Manchester School of Technology. He felt sure that when the resources of the school became known, it would be taken advantage of by many who were already possessed of the knowledge necessary to intelligently use the apparatus provided, and the advantage of the guidance of the expert staff. He would warn the Corporation against inadequate remuneration of staff so common in many schools; the Institute of Technology would undoubtedly be of the greatest value to the manufacturing districts of which Manchester was the centre. Sir James Hoy responded.

The toast of "Our Entertainers," by Mr. H. Lindley, brought the enjoyable and most successful evening to a close.

Obituary.—We learn with great regret that another of the old school of telegraph men has passed away by the death of Mr. Richard Collett. He had held the position of secretary of the Brazilian Submarine—now the Western Telegraph—Co. for 20 years, from which he retired a year or two ago. His connection with submarine telegraphy dates from 1857-8, when he was on the staff of Dr. Wildman Whitehouse during the laying of and experiments with the Atlantic cable, and of the 1866 cable he was the traffic manager. Later he was in the service of the T.C. and M. Co., and several of the telegraph companies in different capacities. The original Society of Telegraph Engineers numbered the late gentleman among its members. He had reached the ripe age of 78 years, and will be missed by the few remaining men of the early Atlantic cable days.

American Electro-Therapeutists.—The twelfth annual meeting of the American Electro-Therapeutic Association—whose proceedings have frequently interested many on this side of the Atlantic—is to be held at Atlantic City, N.J., on September 22nd, 23rd and 24th. D. R. Brower, of Chicago, is president for the year.

Electricity at the Royal Dockyards.—The *Daily News* says that the Admiralty has decided to transfer the supervision of electrical work at the several Royal Dockyards from the Constructive Staff to a separate department under a civilian electrical engineer.

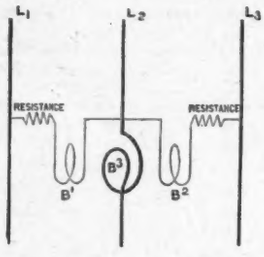
Personal.—The following appointments have been made in the India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., in consequence of the death of the late secretary, Mr. T. J. Lloyd:—Mr. Archer Philip Crouch has been appointed secretary; Mr. Edward Caleb Geale, accountant; and Mr. Frederick Alfred Williams, controller of agencies.

The Sunderland Tramways Committee has appointed Mr. A. R. Dayson as assistant manager and engineer to the tramways. Mr. Dayson is tramways manager at Plymouth.

In our report of the meeting of the Brompton and Kensington Electricity Supply Co.'s meeting last week we said that Mr. Bowden had had eight *months* of illness. This should have read eight *weeks*.

Mr. Hutchins, who has had charge of the Atherton section of the South Lancashire electric tramways, has been appointed to succeed Mr. W. Vaux, as manager of the St. Helens Tramway Co.

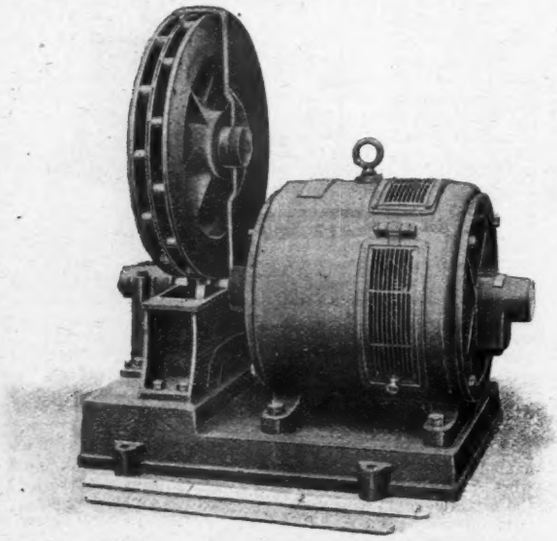
Power-Factor Indicator.—The French Thomson-Houston Co. have recently introduced a power-factor indicator, illustrated diagrammatically herewith. It is intended for use in polyphase current stations, and serves to indicate at any moment the lag of the current behind the E.M.F. The new indicator is based on the following principle:—If two wattmeters are inserted in a three-phase circuit, or a four-phase in equilibrium, the ratio of their readings will vary according to the variations of the power factor. The indicator is, therefore, in a simple form, a double wattmeter; only a single coil, B^3, of thick wire is needed, this being inserted



Power Factor Indicator.

in one of the lines, and two coils of thin or pressure wire, B^1, B^2. The latter are fixed, and the former arranged centrally between them. Although the thick coil is mounted in such a way that it can move, it is in no way controlled, and the wires which connect it to the exterior circuit have a negligible action on the central coil compared with that of the outer coils. The reading scale has been arranged to show variations of 60 per cent. in both directions, unity corresponding with the middle of the scale. The divisions vary in size, those near unity being large, in order to give accurate readings.

Grisson Reducing Gear.—The accompanying illustration shows a Mavor & Coulson enclosed motor arranged with Grisson reducing gear giving a 13 to 1 ratio of reduction. The gear consists of two heart-shaped cams with their tips diametrically opposite, but not in the same plane, mounted on a boss and keyed

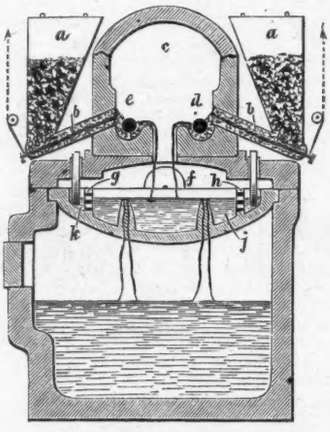


Mavor & Coulson Enclosed Motor.

to the motor shaft. Each of the cams has a separate path in a roller wheel. In effect the arrangement is a pinion and spur gear, the pinion having two teeth only. A high ratio of reduction is attained, and the rolling contact between the cams and roller wheel reduces friction and gives high efficiency and small wear. The cams dip in an oil bath and so ensure copious lubrication. In the arrangement shown, the gear case does not have bearings for the slow-motion shaft, but when required bearings can be provided.

Overhead Wires and Snowstorms.—We have received from Mr. D. Barclay Ross, of Odessa, some picture postcards showing the effect of recent heavy falls of snow upon overhead wires there. Some of the overhead electric light mains, bare copper carrying a 2,000-volt current, were brought down. The effect of the storm on the telephone cables was so disastrous that out of 1,200 subscribers to the system no two could communicate with each other. Although the recent storms in certain parts of this country played considerable havoc with telegraphic wires, we are happily in a much more fortunate position than Odessa.

Electric Glass Furnace.—M. Voelker, in the electric furnace which he has just patented in Germany, and which is shown diagrammatically in the figure, takes advantage of the high temperature that can be obtained by means of the electric arc to melt substances which, by their combination at a high temperature, produce those insoluble silicates known by the general name of glass. The gradual refinement of the glass when in the form of a paste is, on the other hand, effected by taking advantage of the property possessed by the glass itself of becoming conductive at a high temperature, upon which principle is based the incandescence lamp invented by Prof. Nernst. The chamber, *c*, of the furnace, surmounted by a reflecting cupola, contains the electrodes *e*, *d*, and, by means of the Archimedean screws, *b*, receives from the



Voelker Glass Furnace.

receivers *a*, *a*, the raw materials required for the manufacture of glass. The melted mass, which is obtained by the effect of the reaction, and which has to be refined, flows into the lower chamber, *f*, in which are diaphragms arranged for this purpose, shown in the figure at *g* and *h*. In the lateral chambers, *k*, formed by the above-mentioned diaphragms, are two other electrodes, which enable the electric current to be led into the vitreous mass contained in the central chamber. Under the action of the heat generated by the passage of an electric current of high intensity through this mass, the resistance of which is very great, and which absorbs in consequence a considerable amount of energy, the bubbles of gas contained in the mass itself are driven out and the glass becomes clear. The object of the diaphragms is to prevent any fragment that has become detached from the electrodes from falling into the mass of glass.

South African Notes.—Our correspondent at Johannesburg writes as follows:—

Potchefstroom, Transvaal.—Several electric lighting schemes by private enterprise are now being considered by the Public Works Committee; one also includes a system of electric tramways.

Umtata, Cape Colony.—With regard to this scheme of electric lighting, which has already been mentioned in our columns, it is interesting to note that Umtata is a small place on the borders of Griqualand East, about 70 miles from the coast, and is not connected by rail. It is said to be only a Kaffir trading station.

Durban Telephones.—In connection with the new municipal telephones, the borough engineer reported in favour of the Western Electric Co. for the central battery system. The representative of Messrs. Ericsson & Co., of Stockholm, has applied to the Council for permission to be present at a discussion with the borough engineer and the representative of the Western Electric Co. before the latter's tender is accepted.

Maritzburg, Natal.—Mr. R. W. Weightman, who has recently been appointed Chief Engineer of Telephones in the Transvaal, has been made the recipient of a handsome silver tea service and plate by the members of the Postal and Telegraph Department, from which he goes to take up his new appointment.

The Pender Laboratory at University College.—We are informed that Messrs. Crompton & Co., of Chelmsford, have presented to the Pender Electrical Laboratory of University College, London, a complete set of their latest form of potentiometer apparatus, comprising a potentiometer, a movable coil galvanometer, lamp and stand, a volt box, and a number of standard resistances varying from 1 ohm to $\frac{1}{1000}$th ohm, for measuring current. This apparatus will be set up in the Pender Laboratory, and principally used for the electrical measurements of standard incandescent lamps. Also the Electrical Construction Co., Ltd., of Wolverhampton, have kindly promised a 3-H.P. two-phase induction motor for experimental purposes. These gifts are very welcome to Prof. J. A. Fleming and others connected with the electrical side of the College; and it is much to be desired that other firms should imitate this example by assisting the technical branches of the University of London, of which University College is now a constituent college.

(*Continued on page* 450.)

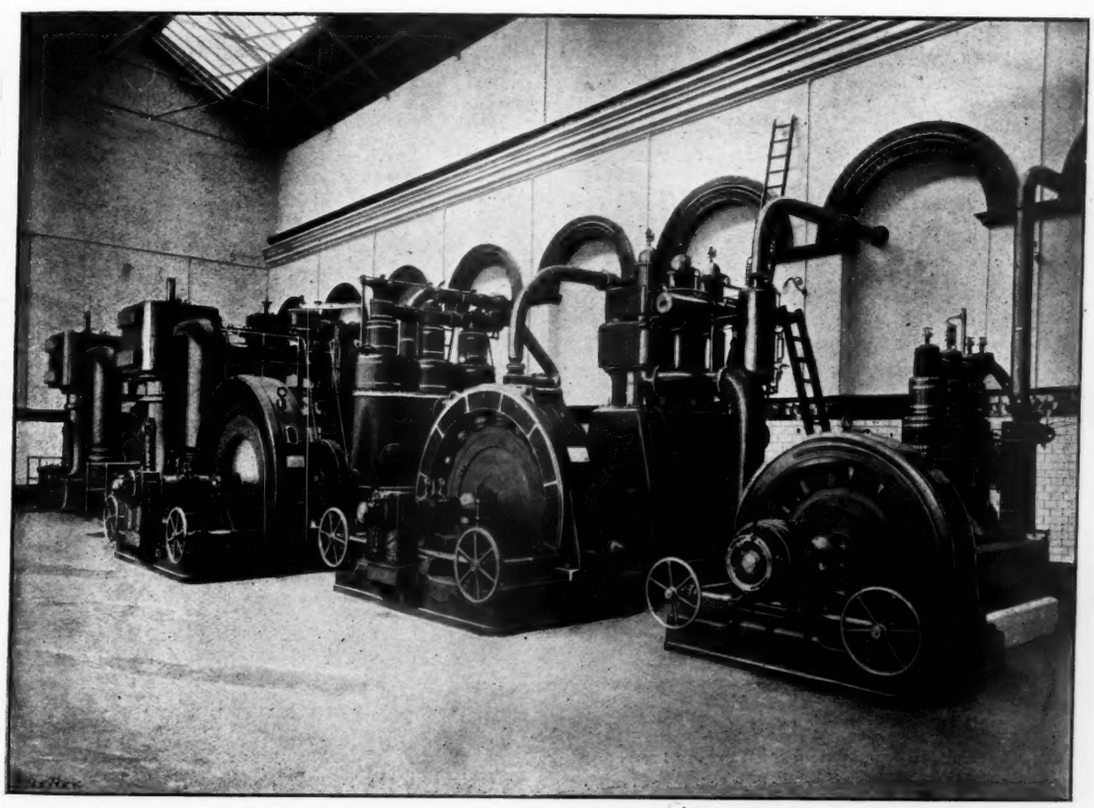
THE ELECTRIC LIGHTING OF EASTBOURNE.

The introduction of electric lighting into Eastbourne dates back to the year 1882, when the Eastbourne Electric Light Co. was incorporated to work a concession obtained from the Hammond Electric Light and Power Co. for lighting by means of the Brush arc lamp.

A contract was entered into with the Eastbourne Local Board for the lighting of the Parade, and in the latter part of September, 1882, this was carried out; thus Eastbourne had the honour of being the first place on the South Coast to adopt electricity, supplied from a central station, for public lighting.

Several of the leading tradesmen of the town also used arc lamps for outside and inside illumination, the energy being taken from the same circuit as that supplying the public lamps. Soon after this, incandescent electric lamps for interior illumination, run in series with the arc lamps, were introduced, but, difficulties arising in the practical working, this system was abandoned, and an alternating-current system with transformers on consumers' premises was introduced just before the town was incorporated in 1883. The first installation of considerable magnitude was carried out at the Town Hall. Since that date the progress of the undertaking has been rapid.

The history of the generating station and distributing system forms an admirable epitome of the progress of the electric lighting industry in many respects, excluding direct-current supply. In the early days of the undertaking, the generating station was at the Old Water Works, the Brush dynamo, and the locomotive boiler with engine underneath, being housed in a galvanised iron structure. This site was found to be unsuitable, and accordingly the Old Brewery in Junction Road was acquired in 1884. Here additional engines and generators were installed as the undertaking progressed, until the plant consisted of various types of machinery, few of which were up to date. At the close of the year 1889 there were two 25 H.P. undertype engines and boilers, driving, by means of leather belts and countershaft, two 25-light Brush arc dynamos and one 25-KW. alternator. Later there followed a 200-H.P. horizontal compound condensing engine, driving a second countershaft by belts, and two 75-KW. Elwell-Parker alternators. The next extension was a 250-H.P. horizontal engine, driving by means of cotton ropes a 100-KW. Lowrie-Hall alternator. Then followed the introduction of direct-coupled units of 50, 150, and 200 KW. capacity respectively. The energy, generated at high pressure, was taken to a double-pole Lowrie-Hall switchboard, and thence distributed through five circuits to different parts of the town, connections being made to transformers placed on consumers' premises, where the high pressure current was transformed to one of low pressure suitable for the supply of incandescent lamps. The distribution was effected by means of cables insulated with vulcanised rubber and drawn into iron pipes.



General View of Generating Plant, showing E.C.C. Alternators.

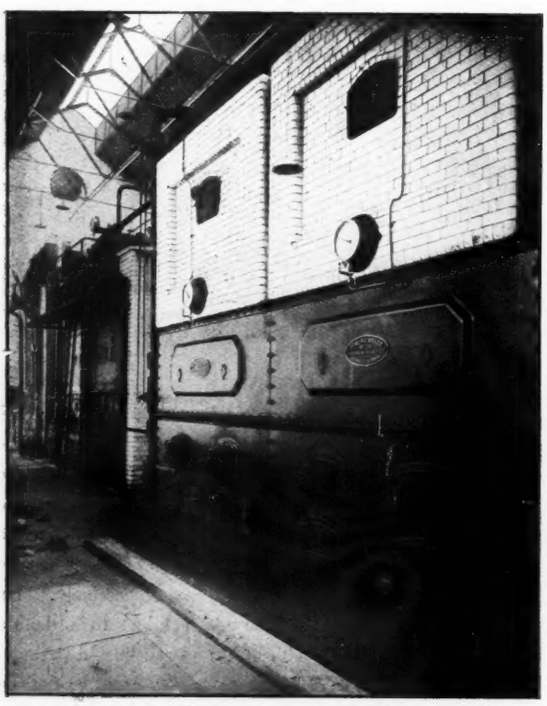
Owing to the deterioration of the rubber insulation, after the cables had been in use a few years "faults" were of frequent occurrence, causing many annoying interruptions of the supply.

View of Arc Lamps on the Parade.

In the year 1899 the Corporation approached the company with a view to purchase, and obtained possession of the undertaking on January 1st, 1900. After the report of the consulting engineer—Mr. W. C. C. Hawtayne—had been considered, it was decided to build new works at the east end of the town, where extensions of the buildings could readily be made as required.

One of the most interesting features of the new installation is the fact that it was carried out without any interruption to the supply, though the primary and secondary pressure, the frequency, and the system of distribution were all changed.

At the old works the current was generated at a pressure



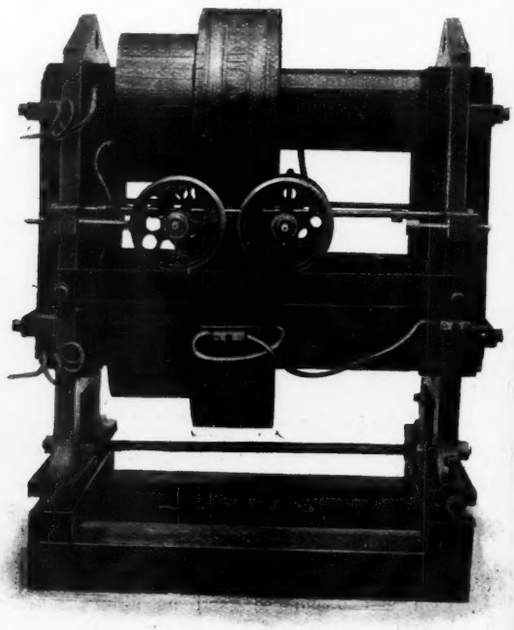
View of Boilers.

of 1,800 volts, and distributed at 100 and 200 volts, 83 cycles per second.

It was decided to alter the high pressure to 2,200 volts, the low pressure to 200 volts only, and the frequency to 50. This necessitated re-winding all the alternators, and keeping the supplies from the two works quite separate during the period of changing over.

The new buildings were completed for occupation in June, 1902. Two vertical engines of 750 H.P. each, of the latest type, combined with 400-KW. alternators, manufactured by Messrs. Ferranti, of Hollinwood, and two Stirling water-tube boilers with an evaporative capacity of 10,000 lbs. of water per hour each, were erected and ready to run by April 24th—before the roof was on the building. At the same time, a new system of high pressure cables was laid from the works to a series of underground transforming chambers in different parts of the town, in which were placed transformers to feed the low pressure distributors. The latter were connected up into a network, from which the service connections to the houses were made, all the small transformers being removed from consumers' premises.

Supply was commenced from the new works on June 10th, 1902, and the work of changing over consumers' connections



Constant Current Transformer.

from the old supply to the new was proceeded with day and night. During this time both generating stations had to be kept running. The old A.C. plant was finally shut down on July 24th, 1902, after having run continuously from August,

1884. The old arc-lighting engine and dynamo, however, continued to run until January 6th, 1903, as the erection of the new arc lamps on the Parade was not then complete. The work of transference of the three modern direct-coupled engines and dynamos and three boilers was then commenced, and the whole have now been removed by, and under the superintendence of, the permanent staff of the electricity department without any accident.

The boiler house is about 92 ft. long, 42 ft. wide, and 30 ft. high to the eaves. The boilers are six in number, viz.:—One Davey-Paxman Economic boiler of 160 H.P., and two Hornsby water-tube boilers of 105 H.P. each, from the old works; one Babcock & Wilcox water-tube boiler of 260 H.P., and two Stirling water-tube boilers of 330 H.P. each.

The new boilers are fitted with superheaters to ensure dry steam at the engines. Opposite the boilers are the coal bunkers, alongside of which it is intended to bring a siding from the railway, and at one end of the bunkers is the pump room, containing a Weir pump, with a capacity of 3,000 gallons per hour; a Worthington pump of 1,800 gallons; and a Pearn fly-wheel plunger pump of 600 gallons capacity. Attached to the feed pumps are small pumps, for use in pumping the re-agent used in softening the feed-water into the feed-water heater and purifier. The latter was supplied by the Sir H. Maxim Co. through Messrs. Babcock and Wilcox, and will deal with 3,000 gallons of water per hour. Over the pump room and part of the coal bunker is a 16,000-gallon water storage tank, and a 2,000-gallon "hot well" tank; a supply of water is derived from the water company's mains, at a cost of 1s. per 1,000 gallons. At the other end of the bunkers is the men's lavatory and bath room.

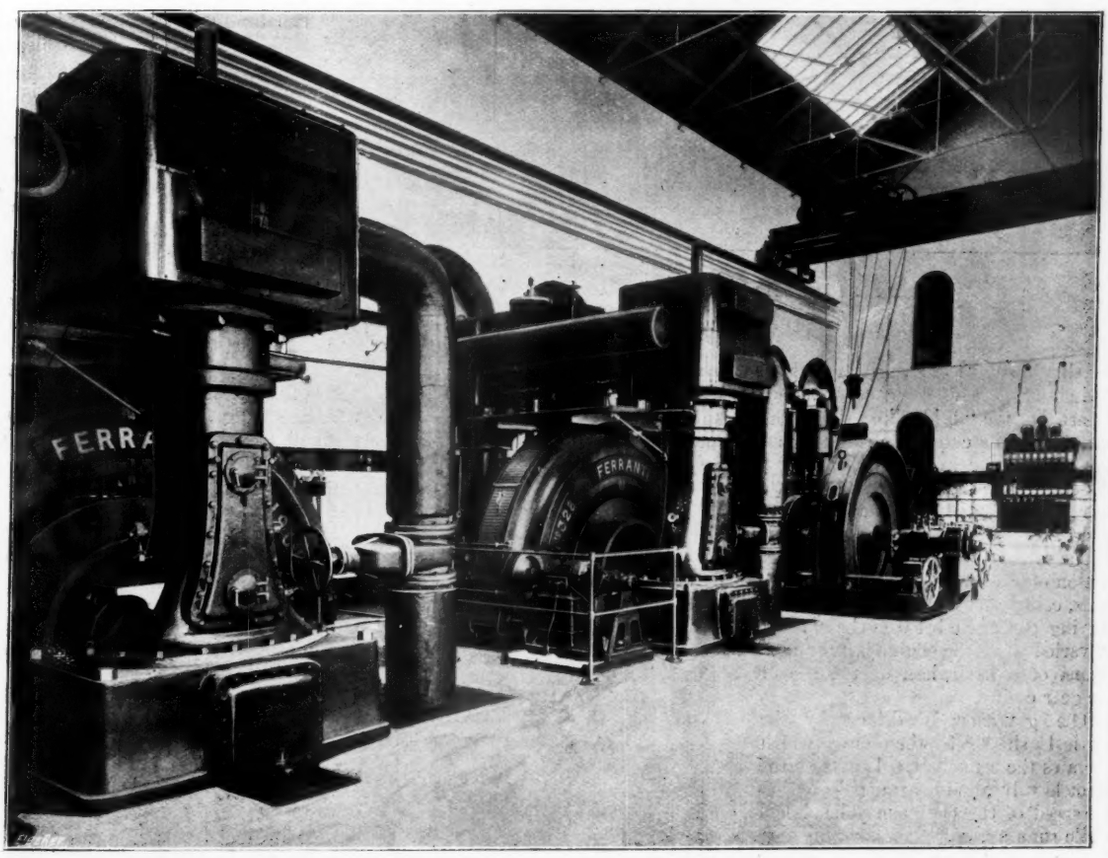
The chimney is 150 ft. in height, and was built by the Alphons Custodis Chimney Construction Co. on their special system. The Green economiser, of 160 tubes, is in a separate building at the base of the chimney; provision is made for the addition of an economiser of equal size when it is required. The scrapers are driven by a Langdon-Davies single-phase motor.

The steam piping, which was supplied by Messrs. Babcock & Wilcox, consists of a single main pipe with branches to boilers and engines.

The engine house is 82 ft. long, 35 ft. wide, and 30 ft. high. The walls are lined with a dado 7 ft. high of white glazed bricks, surmounted by a moulding of brown glazed bricks; above this the walls are finished in Keen's cement. An 18-ton travelling crane spans the room. The floor is laid with mosaic marble, and a basement gives access to the engine foundations, exhaust pipes and cables. The room is well lighted from the roof.

The generating plant consists of the following:—

Two 400-KW. Ferranti engines and alternators; one 200-KW. Willans engine, one 150-KW. Davey-Paxman "Peache" engine, and one 50-KW. Willans engine, coupled to alternators built by the Electric Construction Co., Ltd.



Ferranti Steam Alternators, E.C.C. Alternator, and Switchboard.

The last three sets were removed from the old works, and the generators re-wound for the change of frequency from 83 to 50 cycles per second.

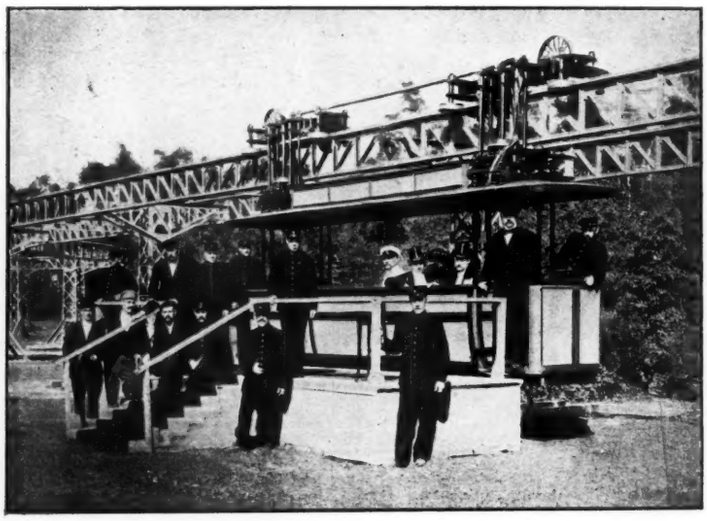
Each alternator has its own exciter; in the Ferranti sets these are driven by ropes from pulleys on the main shafts; the others are attached to the end of the alternator shafts.

The engines supplied by Messrs. Ferranti, Ltd., are two vertical cross compounds, of the standard Ferranti type. The cylinders are 20 and 36 in. in diameter, and the stroke 15 in.; the speed is 250 revolutions per minute.

The engines are designed for a working pressure of 140 lbs. per square inch, and develop the power stated when exhausting to the atmosphere.

Forced lubrication is effected by valveless pumps worked off each end of the crankshaft; besides supplying the chief bearing surfaces, the oil pumps also keep the valve gear always drowned in oil.

The valve gear is of the Ferranti patent positive type, and is placed in the gear casing situated midway between the cylinders. The valves are of the grid type, and operate at half the speed of the engine. They are driven by cams mounted on shafts in the gear casing, which obtain their motion by means of gearing from the crankshaft. The cams are shaped so as to move the valves sharply at opening and closing, and are of constant diameter, so that the motion imparted to the "bridle" on the valve rod is always positive. Thus there is secured the economic advantage of a "trip" gear, with the possibility of running the engine at a much higher speed than is possible with any form of trip gear yet invented. In addition to this, the gear is practically noiseless.



Station on Gatchina Suspended Railway.

The exhaust valves are driven by one cam apiece, but the motion of each steam valve is compounded of that of two cams, called the "opening" and "closing" cams, and by varying the angle between these, the point of cut-off may be varied while the engine is running. This is effected by means of a handwheel on the top of the gear casing.

The governor is driven by the vertical shaft of the gear which operates the cam-shaft. It acts on the throttle valve, and is arranged so that the speed of the engine may be altered while running.

The alternators are Messrs. Ferranti's standard 400-KW. sets, of the "copper" or revolving "disc" type. At 250 revolutions per minute they are capable of giving their full load at either 2,200 or 2,400 volts, and of doing an over-load of 20 per cent. for two hours without any injurious rise in temperature. The frames, as usual, can be moved laterally by means of opening gear, which is easily worked by one man, the frames sliding on rollers placed underneath the feet. This arrangement admits of easy access to the armature and field coils for cleaning purposes.

The exciters are shunt wound, made by Messrs. Thos. Parker, Ltd. They are rope-driven, and run at a speed of 780 revolutions per minute, being designed for an output of 100 amperes at 100 volts.

The Willans engines are of the well-known three-crank compound type, the only variation from the usual appearance being caused by an alteration in the governors, which are mounted on the main frame, and driven by belts from the crankshaft.

The Peache engine, we believe, was the first of its kind to be built for electric lighting purposes.

The 200-KW. E.C.C. alternator will give its normal output at 2,100 volts, at a speed of 333 r.p.m., 50 cycles per second, and a maximum output of 220 KW., at 2,200 volts.

The armature is stationary, with iron core of large section; by means of screw gear and hand wheels, the armature can be moved parallel with the shaft, quite clear of the field magnets, so as to expose the coils.

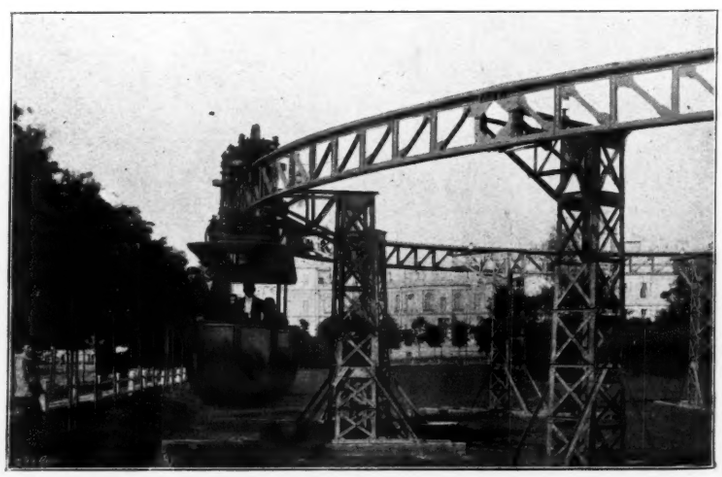
The field magnets consist of a solid ring of cast-steel, with poles securely bolted thereto, and arranged so that the centrifugal force of the moving parts is taken by the ring. The poles are 18 in number.

The bearings are fitted with continuous lubrication. The collecting rings for the exciting current are of phosphor bronze, and each ring is provided with two sets of brushes. The other two E.C.C. machines are of similar type.

The exciters are of the multipolar type; the armature is drum wound, mounted on a sleeve keyed to an extension of the shaft. The magnet poles are of best wrought-iron stampings accurately fitted to a solid cast-steel yoke, the latter being bolted to brackets cast on the alternator bedplate. The brushes are supported by means of a gun-metal ring, carried by brackets fixed to the yoke ring.

A signalling device, consisting of a ground-glass screen with compartments illuminated by glow lamps, is fixed in view of the starting gear of all the engines.

The switchboard, which is mounted on a platform at one end of the room, is of the Ferranti well-known cellular construction, which in detail is so like similar switch-gears to be seen in almost every alternating current station, that only a brief mention of it is necessary here. The fuses are of the Ferranti oil-break type, and the resistances of the design known as open type. All parts are entirely isolated by the well thought-out system of divisions and insulating devices,



Romanoff Suspended Railway Showing Car on 35-ft. Curve.

which has been instrumental in making the entire apparatus so thoroughly substantial and reliable.

The board consists of 10 panels, occuping a space only 6 ft. 6 in. wide, and controls the five alternators, with their exciters, and five feeder circuits; the regulating

resistances for keeping the pressure constant are, as usual, placed in the basement immediately under the board, and are worked by hand-wheels situated in front of each generator panel. A Kelvin voltmeter for the exciters is fixed by the side of the board.

Behind the switchboard is the test room, where meters and other apparatus are tested. At the end of the boiler house is the heavy stores room, men's mess room, and a fitting shop well equipped with lathe, drilling and shaping machines, driven by means of a 2-H.P. Langdon-Davies motor placed on a wall bracket. The general and chief engineer's offices and the entrance hall complete the ground floor. On the upper floor is the committee room, charge-engineer's office, commanding a view of the engine room, mess room, and light stores room, with lavatory. The warming of the offices is carried out by means of steam radiators.

The high-pressure feeders consist of four paper-insulated cables laid on the solid system, in troughs filled up with pitch compound. These cables supply 19 underground substations, in which transformers are placed, reducing the pressure to 200 volts. The low-pressure current is distributed through new concentric paper-insulated and old single rubber-insulated cables, laid solid, or drawn into iron pipes. The single rubber-insulated cables are to be gradually replaced by those of the concentric type. The new cables were supplied by Messrs. W. T. Glover & Co., and the transformers by the British Electric Transformer Manufacturing Co.

The old Brush arc lamps which have lighted up the Parade for so many years have been replaced by new long-burning double-carbon arc lamps, taking 6 ft. of carbon each, and burning for 40 hours without retrimming. These lamps, 33 in number, are in two series circuits, supplied from constant-current transformers with moving coils. Each lamp has a new type of automatic cut-out switch placed in the base of the post, together with the windlass of the raising and lowering gear. Throughout the main streets there are 66 lamps, each supplied through a transformer and double-pole switch fuses from the 200-volt distributors. Five of these lamps in Devonshire Place are suspended over the centre of the street, from span wires attached to steel posts on either side.

The arc lamps, switch gear, transformers and raising and lowering gear were supplied by the Gilbert Arc Lamp Co., of Chingford, and the lamp columns by Messrs. J. and A. Law, of Glasgow.

The price per unit of energy for lighting was reduced, from October 1st of last year, from 7½d. to 6½d., and the charge for energy for heating, cooking, and motive power from 4d. to 3d. Meter rents have also been reduced from 4s. to 2s. 6d. per quarter. As a contrast between the present prices and those in force in 1888, it may be stated that the Electric Light Co. were at that time charging 1s. per unit for a period of one hour per day, and 8d. per unit for the second hour. The supply was also only available from dusk to 1 a.m., and from 6 a.m. till daylight.

The use of electricity for heating and power is rapidly extending in Eastbourne, a large and increasing number of radiators and small motors being connected to the mains.

It is estimated that for the year 1902-1903 the number of 8-C.P. lamps (equivalent) connected will be 55,000, the number of consumers 790, and the units sold 836,525. The maximum load is 633 KW.

The new work and reconstruction have been carried out in accordance with the designs and specifications of Mr. W. C. C. Hawtayne, consulting engineer to the Corporation. The borough electrical engineer is Mr. J. K. Brydges.

Our thanks are due to these gentlemen and to the contractors for their kind assistance in the preparation of this article, and to Mr. Brydges for affording us facilities to photograph the plant in the works.

Southend.—At Southend Police Court on March 3rd, one Redfern, of Sheffield, summoned the Southend Corporation for failing to supply electric light upon premises within their area. Plaintiff, who is an entertainment caterer, stated that he had sustained considerable damage in his business owing to the failure of the electric light. The Bench held the Corporation liable, and imposed a fine of 30s. per day from July 18th to August 18th, with £2 6s. costs, in all a penalty of £38 16s.

THE ROMANOFF SUSPENDED ELECTRIC RAILWAY.

WE illustrate on the facing page two views of a short length of electric suspended railway which was a short time ago laid down for the Emperor of Russia on the system of Mr. H. W. Romanoff. The line is only 700 yards in length, and is laid from the Emperor's palace to the Gatchina railway station. It derives additional interest from the fact that the system has been occupying the attention of the Russian Minister of Interior (Home Office), who has appointed a commission to inquire into its adaptability for a line between St. Petersburg and Moscow.

Mr. Romanoff's system has one feature in common with those of Langen & Enos, *i.e.*, the suspension of cars from the rail, and surrounding it so that they cannot jump from the rails without breakage of several parts simultaneously; but these are said to be the only points of similarity.

In Romanoff's system the permanent way consists of girders cross-joined holding the rail, strengthened by an iron belt serving as a foundation for the rail. The only points to consider are the sizes and dimensions of the car. At present Romanoff uses fixed **T**-shaped standards, supporting double track, but there is nothing to prevent him from making a single track with passing places. The biggest incline on the short railway in Gatchina was ·018, and the smallest curve of 35 ft. radius. The weight of the railway depends, of course, on the weight of the car; for military purposes 75 tons per mile is sufficient; but for passenger purposes it is from 260 to 400 tons per mile.

This system is divided by Romanoff into different types:—

1. The main line railway for heavy traffic and high speed, *i.e.*, 120 miles and over.
2. For high level town traffic without impeding the ordinary street traffic.
3. For military portable railways, or for other purposes such as mining and light goods traffic.
4. For postage purposes, light parcel and express letter cars, which require a very cheap and very light line, and travel at 150 miles per hour.

An estimate has been made of the cost of a railway such as that proposed from St. Petersburg to Moscow, 345 miles long, with 66 trains travelling simultaneously with a speed from 90 to 108 miles per hour, including (1) the cost of construction of permanent way, (2) installation of block signal system, (3) rolling stock of 400 cars for 35 passengers each, (4) workshops and carriage sheds for repairs, (5) 40 generating stations of 1,500 H.P. each, (6) signalling apparatus, (7) cottages for servants, (8) 80 high-level platforms, (9) all foundations for standards, &c. The total cost, according to the report of the Imperial Russian Technical Institute (dated February 15th, 1901), is £23,800 per mile.

Mr. Romanoff is just now on a visit to this country.

New York Electrical Laboratory.—The report of the Electrical Laboratory Commission of New York State was presented to the Legislature on February 17th. The Commission reports that it has found $1,462,615,595 invested in electric railroads, electric light and power companies, telegraph and telephone companies in the State, and $1,680,590,290 in companies engaged in the manufacture of electrical apparatus. The report reviews the disputes likely to arise in the use of electrical energy, which must be settled by expert knowledge. It points out that the first use of such a laboratory would be the calibration of all types of electrical meters; it could also supply expert and impartial evidence demanded by many questions, and the discoveries and inventions resulting from the work of such a laboratory would belong to the people of the State without any of the restrictive or prohibitive features that go with private or co-operate ownership. The laboratory would consist of five separate buildings—a power house, storage building, electro-chemical building, machinery building, and an administration and instrument building. The estimated cost of the buildings is $81,949,000. The equipment of the power house is estimated at $59,700; of the storage building, $1,000; of the electro-chemical building, $20,600; of the machinery building, $63,400; and of the administration and instrument building, $10,800. To this, miscellaneous costs of $27,400 are added, and for superintendence, contingencies and architectural treatment, $10,551, the estimated total expenditure required being $275,000, which sum the Commission recommends should be appropriated.

NOTES.

(*Continued from page* 444.)

Institution of Electrical Engineers.—The programme arranged for the visit to Italy, which takes place on April 1st to 10th, has been issued to members. The first item is a visit to the Valtellina Railway, the only one in existence operated for public traffic with three-phase current at 3,000 volts. A visit will be paid to the tomb of Volta on Sunday, April 5th. On the following days the Milan-Gallarate Electric Railway, the power station at Paderno and Messrs. Gavazzi's silk works, a number of works in Milan, the Vizzola power station, Messrs. Franco Tosi's engine works, and Messrs. Fura & Banfi's cotton mill will be visited. The Milan-Gallarate Railway was described by Prof. C. A. Carus-Wilson in a paper read before the Institution, and abstracted in our issue of May 30th, 1902; and an illustrated account of the Paderno power station was given in our issue of October 5th, 1900. The network of electric railways which is gradually spreading over Northern Italy renders this district of great interest to electrical and railway engineers, and the visit will undoubtedly prove a source of both pleasure and instruction to those who take part in it. We notice that members who elect to travel independently of the main party will be expected to contribute to the incidental expenses incurred in the organisation of the tour; this is only reasonable.

An E.C.C. Dinner.—The Drawing Office Dinner of the Electric Construction Co. was held on March 7th, at Wolverhampton, under the chairmanship of Mr. Hawkins, the genial head of that department. After dinner the members of the drawing office gave a musical programme, which was greatly enjoyed.

The Flight of a Golf Ball.—Under this title some interesting experiments, conducted with the aid of electric-spark photography, are described in the current *Strand*. The experiments were carried out by Messrs. Frank Broadbent and H. Smith, with the object of detecting and measuring the spin acquired by a golf ball in the act of being driven off the tee, which sometimes causes it to describe such extraordinary curves. Doubtless golfers will hail this new and plausible excuse with acclamation.

Errata.—In our abstract of Mr. M. B. Field's paper on "Resonance" last week, the following corrections should have been made:—p. 416, column 2, line 6, for "pair of poles" read "pole"; line 61, for "1·33 v_1" read "1·33 × 10^{-4} v_1"; p. 417, line 14, delete "corresponding to fig. 17"; line 22, for "93,700" read "9,370."

Manchester Ship Canal Cranes.—In our article on this subject last week it should have been stated that the cranes were built and equipped to the specification of the Manchester Ship Canal Co., of which Mr. Fox is the chief mechanical engineer.

Appointments Vacant.—Deputy electrical engineer for Salford at £250; shift engineer at Partick at 30s.; the Bermondsey B.C. requires a foreman for its destructor at £2. See "Official Notices" this week.

Electrical Exhibition.—The Isle of Thanet Electric Tramways and Lighting Co. propose to hold an electrical exhibition at their power house during April. See our "Official Notices" this week.

Electrical Exhibits for the Fire Exhibition.—We have received the following letter from Mr. James Swinburne, the chairman of the Electrical Sub-Committee of the International Fire Exhibition:—"The importance of fire telegraphy, fire alarms and fire telephones in connection with the fire service, as also the importance of electrical control systems for watchmen and others, makes it a matter of considerable interest to all associated with electrical engineering that the electrical section of the forthcoming Fire Exhibition should be thoroughly representative of the appliances now in use for this this character of electrical work. It is also of general importance to the community to encourage in every possible way the equipment of cities, villages, factories, shops, hotels, &c., with electrical fire-alarms and fire-telegraphic apparatus, as it is the 'early call' of the fire-fighting forces that plays such an important part in the effectual extinguishing of fires. Besides questions of electrical telegraphy as connected with fire-fighting there are, however, the two preventive problems of the electrical safeguard in electrical installations and the safeguard for protection from lightning, which both considerably affect the electrical industry in its relations to the general fire protection of the country. The attention of the electrical trade is hence particularly called to the impending International Fire Exhibition, and it is suggested that an effort should be made by all electrical firms in any way associated with the work to exhibit what they consider to be most practicable in this direction. The International Fire Exhibition at Earl's Court will be visited on this occasion, not only by general exhibition visitors, but by a large number of professional men, public officials and municipal delegates interested in the subject, while the International Fire Prevention Congress, to be held in July, will alone bring together a large number of those seriously concerned in the matter both from at home, the colonies and abroad. Further, the National Fire Brigades' Union Tournament, organised by the National Fire Brigades' Union—which has a membership of over 500 provincial brigades—will bring to the Exhibition a very large number of fire brigade officers and men, all anxious, more or less, to improve their local resources. Again, there will probably be an Ambulance Congress, which will bring together many of the leading officers in the various ambulance services, who are becoming more and more interested in the question of rapid intercommunication of a similar character to that of fire telegraphy. Regarding awards—diplomas for gold, silver and bronze medals will be accorded by sections and sub-sections on a system to be approved by the Electrical Committee, and a jury of a thoroughly representative and independent character will make these awards."

No doubt a copy of this communication will reach the hands of numerous electrical manufacturers, and we trust that they will be able to make a good showing of modern work at this exhibition, which opens in a few months' time.

The Lighting of Edinburgh Streets.—In a paper on "Artificial Lighting in the Nineteenth Century," read on Wednesday, 25th ult., by Mr. Daniel Macfie, before the Edinburgh Architectural Association, the lecturer said it was little short of a scandal that in twentieth century Edinburgh, a unique installation of an antiquated and effete style of gas-lamp existed side by side with the electric arc lamp. There were some six thoroughfares in the city with specimen installations of incandescent lighting. These with the 38 miles of electrically-lighted streets, brought into stronger relief the 150 miles of streets still lighted with an effete style of gas lamp. The juxtaposition of the electric arc lamp and this type of gas lamp was not matched in the United Kingdom, and it was not creditable to the municipal authorities that while they had widely and generously adopted the electric arc lamp for street lighting no sustained effort had been made to improve the system of gas lighting already existing.

THE CENTRAL STATION ENGINEER.

In consequence of the resignation of Mr. A. Bromley Holmes the following promotions were made as from March 1st:—Mr. W. H. Collis to the position of deputy resident engineer, with increase of salary from £450 to £500: Mr. Wm. Norbie to be distribution engineer, with increase of salary from £190 to £215 per annum; Mr. B. H. Collins, chief clerk, salary increased from £300 to £350 per annum.

The Annes U.D.C. has increased the salary of Mr. J. H. Clothier, electrical engineer, from £175 to £200 per annum, with an honorarium of £50 for extra work in connection with the proposed tramway scheme.

The Electricity Committee of Grimsby Corporation has recommended that the salary of Mr. Vignoles, electrical engineer, shall be increased from £300 to £350 per annum.

The St. Helens T.C. has retained Mr. Highfield as consulting electrical engineer, for such period as may be necessary to cover all work in connection with the contemplated extension of the works, and the settlement of the difficulties with the Tramway Co.

Mr. H. R. Mott, chief assistant in the testing department of the Metropolitan Electric Supply Co., Ltd., has been appointed assistant electrical inspector to the City Corporation.

Recommendations to increase the salaries of Mr. Gay, the electrical engineer, and Mr. Yeaman, assistant electrical engineer, were negatived by 27 votes to 12 at the last meeting of the Islington Borough Council.

At a recent meeting of the East London (Cape Colony) Borough Council, the Mayor reported that Mr. Cuthbert Wilson-Moore had been appointed town electrical engineer.

As a result of some reorganisation in staff at the Leyton electricity works, Mr. Owen Cox has been appointed outdoor engineer, at a salary of £130 rising to £180—and Mr. Noles, senior charge engineer has been appointed station engineer, with £150 salary, rising to £180.

The Portsmouth E.L. Committee has recommended the promotion of Mr. Fowle to station superintendent at a commencing salary of £300, rising to £500.

Tonbridge U.D.C. has appointed Mr. Wood, of Maidstone, as shift engineer at the electricity works.

On 7th inst. a smoking concert was held at the "Clapham Hotel," Lowestoft, on the occasion of the departure of Messrs. A. E. Loos, chief assistant, S. Foster, assistant engineer, and R. Stockbridge, from the electricity works. Mr. W. H. Ridpath, outside superintending engineer, took the chair, and on behalf of the staff, presented Messrs. Loos and Foster with writing cabinets, and Mr. R. Stockbridge with a letter case.

On 6th inst. the staff of the Taunton electricity works presented their chief, Mr. E. B. Thornhill, with a case of useful electrical instruments as a token of esteem, and also as a mark of sympathy with him in the recent prosecution against him.

The Sunderland Tramways Committee selected four candidates for the position of resident electrical engineer to the tramways to succeed Mr. Andrews. The votes were divided between Mr. Dayson, of Plymouth tramways, and Mr. Walter Binns, of Newcastle Corporation tramways. Mr. Dayson secured the appointment at £200, rising to £250.

Mr. W. A. L. Massey, at present in the service of the British Insulated and Helsby Cables, Ltd., has been appointed assistant (distributing engineer) at Willesden U.D.C. electricity works.

ELECTRICITY SUPPLY ACCOUNTS.

Northampton Electric Light and Power Co., Ltd.

The returns of this company for the past year indicate that substantial progress is being made.

New consumers have been added, greatly in excess of those in the previous 12 months, and with a view to furthering the supply of energy for motive power, which is greatly on the increase, the directors have adopted a scheme for hiring out motors.

During the year negotiations for the sale of the undertaking to the Northampton Corporation were opened at the request of that body, but led to no definite result.

Owing to its excellent prospects the company intends to apply for a provisional order to enable its operations to be extended to the suburbs and outlying districts.

The progress of the undertaking during the last six years will be gathered from the following figures:—

Year ending Dec. 31st.	Equiv. 8-c.p. lamps.	Number of consumers.	Units sold.	Revenue from sale of current.	Average revenue per unit sold.	Cost per unit.	Dividend.
1897	11,084	171	114,676	£3,032	6·35d.	3·95d.	2 %
1898	13,061	202	138,445	3,561	6·17d.	4·00d.	2 %
1899	19,763	329	185,412	3,919	5·08d.	3·07d.	2 %
1900	25,459	445	251,153	5,171	4·94d.	3·25d.	2 %
1901	29,121	502	286,890	5 873	4 89d.	2·54d.	3½ %
1902	32,967	580	338,541	6,636	4·70d.	2·10d.	4½ %

An analysis of the working expenses, &c, on the same basis as the municipal undertakings dealt with in these columns, will be found below.

The items of expenditure on works costs compare favourably with those of undertakings having a larger output—coal at ·46d. per unit being much below the average—and the total costs standing at slightly over 2d. per unit, as compared with 2¼d. in the previous year. Mr. G. H. Jackson is the chief engineer to the company.

General Statement.

Year ending December 31st—	1901.	1902.	Inc.
Total capital expenditure	£80,543	£85,435	£4,892
Total units sold	286,890	338,541	51,651
Equiv. number of 8-c.p. lamps connected...	29,121	32,967	3,846
Maximum load in kw.	—	430	—
Gross revenue	£6,744	£7,639	£895
Gross expenditure	£3 036	£2,927	—£109
Gross profit	£3,708	£4,712	£1,004
Average price per unit sold	4 89d.	4·70d.	—·19d.

Revenue.

	Per unit.	Gross.
Sale of current	4·70d.	£6,636
Meter rents...	·10d.	2 7
Rent receivable, &c.	·23d.	324
Premium on stock and pupils' fees ...	·32d.	452
Gross revenue	5·35d.	— £7,639

Expenditure.

	Per unit.	Gross.
Coal	·46d.	573
Oil, waste, water and engine room stores	·04d.	62
Salaries and wages incurred in generation and distribution, &c.	·69d.	981
Repairs and maintenance of engines, boilers, dynamos, mains, &c.	·33d.	469
Works costs	1·52d.	£2,085
Rent, rates and taxes	·20d.	286
Management expenses, directors' fees, salaries of engineer, secretary, accountant, &c.	·21d.	300
General establishment charges, stationery, printing, law charges and insurance ...	·15d.	224
Sundry	·02d.	32
Gross expenditure	2·10d.	— £2,927

Profit.

Interest on debentures	£1,189
„ „ temporary loans	160
Half-year dividend preference shares	403
Preliminary expenses	302
Depreciation	800
Dividend on preference and ordinary shares ...	1,820
Carried forward to balance in hand	38
Gross profit ... ... —	£4,712

The gross profit for the year was £4,712 as compared with £3,708 for the year ending December 31st, 1901, and was allocated as shown. A balance of £38 remains on the year's working, and with £35 from the previous year, makes a total balance of £74 carried forward.

It will be noted that a sum of £800 has been carried to the depreciation fund, which now stands at £3,900.

The prices for lighting have been reduced and now stand at 6d and 3d. per unit on the Brighton system, motors at 2d. per unit with discounts.

Worcester Corporation Electricity Accounts.

The returns of the Worcester electrical department for the year ending 1902 are of an exceedingly satisfactory nature. The accounts indicate that a substantial profit has been realised, due largely to the increased proportion of energy obtained from water-power—an indirect result of a wet year. The percentages of water-power obtained during the years 1901 and 1902 are shown by the following table:—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average for year.
1901..	40·7	67·3	55·0	54 9	73·9	42·7	32·8	17·7	9·7	8·8	26·4	34·4	37 2
1902..	59·1	59·9	70·7	73·5	75·1	85·5	48·8	53·9	51 4	47 9	49·1	48·4	58·6

During the year the department has successfully started the new Hylton Road generating station and laid new lighting and traction cables; it has also changed over a portion of the supply from the alternating to the continuous-current system. Mr. C. J. Sutherland, the city electrical engineer, and his ordinary staff have been responsible for this work, and are to be congratulated on its successful issue. The progress of the output during the past five years will be gathered from the following figures:—

	1902.	1901.	1900.	1899.	1898.
Total units generated ...	906,140	907,086	842,132	710,416	610,492
Units sold:—					
Public lamps	148,640	125,878	106,049	109,600	108,400
Private consumers ...	524,414	536,691	519,690	441,837	365,944
Total	673,054	662,569	625,739	551,437	474,344

It will be noticed that a large reduction in transmission loss has been made—for units generated are less than in the previous year—although 10,488 units more have been sold.

General Statement.

Year ending March 31st.	1901.	1902.	Inc.
Total capital expenditure ...	£88,879	£114,815	£25,936
Number of units sold	662,569	673,054	10,485
No. of lamps connected	36,242	39,186	2,944
Number of consumers	540	577	37
Maximum load in kw.	538	510	—28
Gross revenue	£10,856	£11,062	£206
Gross expenditure...	£5,326	£5,002	—£324
Gross profit	£5,530	£6,060	£530
Average price per unit sold ..	3·76d.	3·61d.	—·15d.

The unusually small increase in revenue over the previous year is accounted for by the decreased energy supplied to the water-works, who are introducing steam pumping plant, thus the net increase in units sold was only 10,485, compared with 36,830 in 1901; the private units, however, show a percentage increase of 5·24, as compared with 4·35 in 1901. The prices charged vary from 1¾d. to 7¼d. per unit. The averages obtained were as follows:—

	Units.	Revenue.	Average price obtained.
Water-works motors	110,765	£807	1·25d.
Public lamps	148,640	£1,228	1·98d.
Private lighting	410,220	£8,041	4·70d.
Private motors	3,429	£50	3·48d.
	672,054	£10,126	3·61d.

The revenue for the past two years was as follows:—

Revenue Statement.

Year ending Dec. 31st. ..	1901. Gross.	1901. Per unit.	1902. Gross.	1902. Per unit.	Inc.
Sale of energy	£10,392	3·76d.	£10,567	3·77d.	·01d.
Motor and meter rents ..	239	·09d.	259	·09d.	·00d.
Property rents	—	—	197	·07d.	·07d.
Sale of old material	26	·01d.	—	—	—·01d.
Sundry	199	·07d.	39	·01d.	—·06d.
Gross revenue ...	£10,856	3·93d.	£11,062	3·94d.	·01d.

In the works costs, it will be noted that the cost of coal shows a considerable reduction on the previous year, being nearly ¼d. per unit less. This is due to several circumstances, including the larger proportion of water power used, and some reduction in the price of coal. The remaining items are about the same, and the total costs are less by ·15d. than in the previous year.

Cost of Production.

For the year ending Dec. 31st—	1901. Gross.	1901. Per unit.	1902. Gross.	1902. Per unit.	Inc.
Coal..	£2,351	·85d.	£1,779	·63d.	—·22d.
Oil, waste, water, and engine room stores.	182	·07d.	192	·07d.	·00d.
Salaries and wages incurred in generation and distribution, and attendance on public lamps.	1,011	·37d.	1,238	·44d.	·07d.
Repairs and maintenance of engines, boilers, dynamos, mains, public lamps, &c.	917	·33d.	874	·31d.	—·02d.
Works cost ...	£4,461	1·62d.	£4,083	1·45d.	—·17d.
Rent, rates and taxes ..	112	·04d.	122	·04d.	·00d.
Management expenses, salaries of engineer, secretary, clerical staff.	504	·18d.	487	·18d.	·00d.
General establishment charges, stationery, printing, insurance, law, &c.	173	·06d.	198	·07d.	·01d.
Sundry expenses, free wiring, lamps, &c.	76	·03d.	*112	·04d.	·01d.
Total costs ...	£5,326	1·93d.	£5,002	1·78d.	—·15d.

* Includes an item of £20 for proportion of rents re Tybridge Street property.

The decreased expenditure and increased revenue together contribute to a profit of £6,060, some £530 in excess of the previous year; after paying off capital charges, and allocating sums of £600 and £500 respectively to the reserve fund and the district rate, a balance is left on the year's working of £51, which, with the balance from the previous account of £1,479, makes a total balance in hand of £1,530, which is carried forward.

Profit Statement.

	1901.	1902.
Interest on loans	£2,247	£2,892
Sinking fund for repayments	1,898	2,017
Transferred to reserve fund	—	600
Contribution to general district rate	—	500
Year's balance carried forward	1,385	51
Gross profit	£5,530	£6,060

CITY NOTES.

Notting Hill Electric Lighting Co.

The sixteenth ordinary general meeting of this company was held on Tuesday at the offices, High Street, Notting Hill Gate.

Sir Wm. Crookes, F.R.S., presided, and in moving the adoption of the report and balance-sheet, said that he had occupied the chair at their meetings on 15 occasions. Turning to the report, he said that no further shares had been issued during the past year, but the balance of £12,864 on shares allotted in the previous year was paid up and the whole of the shares now issued were fully paid, leaving £56,000 of ordinary share capital for further use if required. The statement of loan capital had been altered to give effect to the resolution passed at the last general meeting, increasing the borrowing powers from £50,000 to £72,000, being 50 per cent. of the capital for the time being paid up. But the directors had not required to exercise those powers, and the total paid-up share and loan capital of the company at the end of the year therefore amounted to £194,000. It had been found necessary, however, to issue in the current year a small amount of only £5,000 of the unissued debentures in order to meet the demand for fresh capital expenditure. The capital account showed an increase of the expenditure side of £13,777 14s. 10d. principally made up of the two items, "Fixed machinery and mains." The additional machinery which had been purchased was necessary to meet the increased output, and took the form of motor-generators, which had been fixed at the Bulmer Place and Holland Mews stations, and were driven by the power received from the Wood Lane works. Just over £7,000 was spent on new mains, which were laid principally in Oxford and Cambridge Gardens and other roads in North Kensington, in order to obtain sufficient load in that district to keep the Lancaster Road station in constant work. The number of customers on those lines of extension was not yet large, but it was to be hoped that with the reduction in the price of current the demand in that part of their area would be more satisfactory, and would justify the capital expenditure. The only other large expenditure on mains was to meet the demands of the Royal Borough of Kensington for electricity for public lighting, several of the principal streets having been so lighted. There were only two other items of importance, one being £729 expended in completing the building of the sub-stations, and £701 in completing the conversion from leasehold to freehold of the property at Lancaster Road by the purchase of the reversionary interest. The total capital expended was £210,257 16s. 1d., being £16,257 16s. 1d. in excess of the capital received, the balance being provided by employing the reserve fund in the business. The revenue account showed a profit of £14,609 6s. 2d., which was an increase £1,563 compared with the previous year. Nearly the whole of the generating costs were considerably lower, as most of the current had been taken from the Wood Lane works, it having been found to be more economical to take current from those works than to generate it themselves at the Notting Hill station, reserving the steam plant at the latter place to supply current during the period of maximum requirement. Year by year the amount of rates and taxes became a more serious item, and it was now nearly treble what it was in the year 1900, whilst for the current 12 months it would be again higher. The Borough of Kensington should not overlook the fact that by the adoption of municipal trading, which had been discussed so much of late, and buying up of electric light companies, they would lose many thousands of pounds in rates that were being paid by the different companies supplying electricity in the parish. The fact was, that they were making out of one of the company's works a bigger profit than the borough would make if it owned the works. The management expenses still remained at about £3,000, and although the total sales had increased nearly 20 per cent., the percentage of increase in the expenses of management was hardly perceptible. There was one other item on the debit side of the revenue account to which he must refer, and that was the £273 spent in law costs. That, as was explained in the directors' report, had been spent in successfully opposing the London County Council's Electric Supply Bill, which was introduced into Parliament last year. Had that Bill been passed, undoubtedly it would have been seriously injurious to the interests of this company, and also to those other companies supplying electricity in London, as it interfered in many ways with the arrangement between them and the local authorities. Although the measure was defeated, it was being brought forward again this session, and had already been read a first time in the House of Commons, so that it would be necessary for them again to incur the expense of opposing. As a matter of fact, they had already sealed the petition against the Bill, and he believed the other London companies had taken the same course. The credit side of the account showed a gratifying increase, and was about 18 per cent. above the total for the previous year. The net revenue account showed a profit balance of £8,319 11s. 10d., which was more than £1,100 in excess of the last year. It would be seen that they had transferred to the depreciation and renewal fund a sum of £1,284 11s. 5d., in addition to contributing their proportion of the Wood Lane works sinking fund, amounting to £1,045 18s. 9d. With regard to the depreciation, renewal and reserve fund, £784 11s. 5d. represented the cost of renewing the accumulators, and was the first item they had charged against that fund, which was provided for renewals. An item of £1,000 to the debit of that account was a mere transfer in the books of balance of preliminary expenses, &c., from one account to the other. Nothing was ever paid for goodwill, and no general contract was made, so that the whole of the assets were represented at actual prime cost, which they considered a sounder method of finance than first loading the capital, and then unloading it by writing off. The Kensington and Notting Hill debenture stock sinking fund was the new account added last year to show the company's proportion of the sinking fund which was being created for the redemption of the joint debenture stock. The stock had to be redeemed in the year 1931, and the joint station would then belong to the Kensington and Knightsbridge Co. and themselves in proportion to the amount of their respective contributions. The sinking fund was being invested in trustee securities, and had been calculated to redeem the debentures in 1931 at a low rate of interest. In the year they commenced with a loss of £554; in 1896 there was a profit of £4,736, the profit for the past year having been £14,609. The increase in business had been steady; 339 new customers were connected last year as compared with 254 in the previous year. The directors recommended a dividend of 6 per cent., but a larger distribution might be looked forward to in future years. The increase in the profit last year of £1,500 was absorbed by another £22,000 of ordinary share capital, ranking for dividend. The Wood Lane works were running successfully, and the price of current had been reduced to 5d. per unit. This reduction had been made in anticipation of an increase in the number of consumers. The price for day current for power purposes, &c., had also been lowered, and they hoped to obtain a satisfactory day load.

The motion for the adoption of the report was seconded by Mr. Arthur E. Franklin, and carried after some discussion. The retiring directors and the auditors having been re-elected, the meeting terminated.

Kensington and Knightsbridge Electric Lighting Co.

The meeting of this company was held at Westminster, S.W., on Wednesday last week. Sir Frek. Bramwell, Bart., F.R.S., presided, and, in moving the adoption of the report, said he had very few observations to make in respect of that motion, for the accounts were, he thought, eminently satisfactory. They had an increased revenue of a little over 13 per cent., and they had an increased expenditure of a little over 2 per cent., and these, he thought, were very satisfactory items. The saving in expenditure had arisen very largely indeed from the difference in the price of coal. As regarded the price of coal and the consequent reduction of profits which might arise from the variation of that price, the directors could do very little beyond making a few contracts in

advance in fear and trembling. However, they did all they possibly could to get the coal to the joint generating station at Wood Lane on economic terms by providing their own wagons, and so on, and when they got their coal there the engineers did all they could in the way of getting the best out of the fuel by some of the most admirable combustion he had ever witnessed. They sent no smoke out of their chimney and deposited no soot by their economisers, and he believed all the good of the coal was got out of it. Another source of economy was that they had got a much larger proportion of their units from the joint station than formerly, and that operated in two ways. In the first place, the dead charges became less per unit as the units were increased; and, secondly, the units were produced from coal they delivered into the bunkers there at, roughly speaking, two-thirds of what they had to pay for their stations in Kensington and Chapel Place. These were considerable sources of economy. But one great source of their prosperity was the care and attention given by the staff, and especially by the two heads of it, Mr. Miller, the engineer, and Mr. Erskine, the secretary. Last year there was some dissatisfaction, and some shareholders attended the meeting and complained, but they could not have their cake and eat it. They had been issuing ordinary shares at par, as he thought it was their duty to do, and for a time, of course, that put an extra dividend upon them for capital that had not borne fruit. Now that capital had borne fruit, and they already saw the very substantial increase in the earnings they had made that year. They proposed to pay the 10 per cent. dividend which they had paid before, and to carry forward the sum of £5,832. They thought it well to have a certain amount in hand for any unexpected casualty or for making up the dividend if they had a bad year again with coal, and further, they thought it better that the company should get the reputation of paying a uniform dividend on which investors could rely than to have a fluctuating one, up and down from time to time. There was one thing in regard to which he thought they were entitled to complain; that was the conduct of the London County Council in bringing forward this year a Bill practically identical with that which the House of Commons threw out last year. He would not go into the details of that Bill, but they were of the usual grasping character of the County Council, and he did complain that they should be allowed to bring it forward two years in succession. Their law charges were very moderate indeed, £340, but of that sum the major portion was due to the abortive attempt of the County Council, and this year they must oppose the Bill again, because it was contrary to their interests and to those of other companies. The hard thing was that not only had they to pay their own costs, but as ratepayers they had to pay the costs of the County Council. Another matter was the enormous amount of the rates, which were based rateably on their income-tax, and they came out that year to as much as £4,900.

Sir Charles Grant seconded the adoption of the report, and the resolution was agreed to.

On the motion of the Chairman, seconded by Mr. G. H. Hopkinson, it was agreed that the interim dividend of 5 per cent. be approved, and that a further dividend of 5 per cent. be declared.

The Chairman proposed the re-election of Sir Charles Grant as a director, and this was seconded by Colonel R. E. Crompton and agreed to.

The auditors were re-elected on the proposition of Mr. Metcalfe, seconded by Mr. Miller, and a vote of thanks accorded to the chairman on the motion of Mr. R. W. Wallace, K.C., seconded by Mr. Hopkinson.

London Electric Supply Corporation.

Mr. R. H. Benson presided at the meeting held last Friday at Winchester House, and in moving the adoption of the report, said that the satisfactory result of the year's working was produced by both an increase of gross revenue, and a decrease in expenses. The former increased by £7,000 from sales of current, and the latter included a decrease of nearly £3,000 in the coal bill. It was not that coal was much cheaper, for the difference was only 6d. per ton, but there was a greatly reduced consumption. The reserve now amounted to £9,000, and their great object must be to increase that fund year by year, rather than to declare dividends on the ordinary capital. They must have this fund as an insurance against antiquation of plant and risk of accidents. He asked the shareholders' sanction of the policy of building up the property with all the surplus that they might for the present earn over the preference stock dividend. The company had made a three years' contract with the L.C.C. for supplying power for their tramways. The Council were to find all the plant and mains, so that all the company would have to find was another battery of boilers, at a cost of £7,000. The contract was taken at a rate which would remunerate the company, but supply would not commence until toward the end of the year. After referring to the question of municipal competition in connection with the new Bill of the L.C.C., and showing that the Council was attempting to over-ride the Electric Lighting Acts of 1882, on the faith of which most of the money was invested in the company, the chairman said that in six years the company's net revenue had increased by 113 per cent., but its capital account (excepting the amount written off in 1898) by only 35 per cent.

Sir W. H. Preece seconded the motion.

Mr. R. S. Bain, the managing director, said that the capital expended during 1902 was £22,000, as compared with £37,000 in 1901. While the gross revenue was increased by over £7,000, or 10 per cent., the profit had increased by over £10,000, or 40 per cent. This large increase in profit was owing to the economies effected in the cost of generation. The total expenditure was less by £3,000, although they had sold nearly half a million more units. The number of units sold was 4,036,593, as against 3,546,400 in 1901. The cost per unit sold was reduced from 3d. to 2½d. = 18 per cent. The principal saving was in coal, the consumption being 1902, 16,241 tons; in 1901, 18,900 tons; and in 1900, 26,710 tons. That decrease in consumption, taken in conjunction with the increase in units sold, showed a saving of 25 per cent. in the coal bill for the year; and considering that they were at present working non-condensing, that might be taken as a very satisfactory figure. They were still reducing that consumption. Although they sold 14 per cent. more units than in 1901, their gross receipts had only increased by 10 per cent.; that was owing to the keen competition to which they were subjected. The company had no less than 11 competitors, nine companies and two municipalities, and they were threatened with yet another in the form of the L.C.C. It might give some idea of what that competition meant if he told them that one company was canvassing customers in those districts where it had competitive powers at 4d. per unit, while in the adjoining borough where it had a monopoly, it was charging 7d. per unit. In two districts where they had municipal competition, the published accounts of one showed that they were working at a loss, to which this company as large ratepayers in the borough had to contribute. The effect of all this competition was to reduce the average per unit sold, which had steadily decreased since 1894; in 1897 it was 5d., in 1901 4¾d. and last year only 4½d. As against this, however, the average consumption per lamp installed had increased from 19½ to 20½ units. The costs had also shown a steady diminution, and what was of even greater importance, the proportion of units sold to units generated had shown a steady increase during the last 10 years. In 1894 they only sold 52½ per cent. of the generated units; in 1897, 62 per cent.; in 1900, 70 per cent; and last year slightly over 73, per cent. There was an increase of efficiency of 21½ per cent. since 1894. An efficiency of 73 per cent. in an alternating supply with two transformations might be considered satisfactory, when it was remembered that one of their competitors working last year on the continuous system only sold 70 per cent. of the current generated. The lamp connections had also increased, and since the end of the year a further 5,000 lamps had been applied for. They had had no interruption during the year. As regarded capital outlay for 1903 the new 1,500-kw. plant had not yet been completed, but when it was they would have sufficient plant for their requirements—unless some very abnormal demand arose—for the next two years. Hitherto their station had been running non-condensing, and although the engines had given satisfactory results for such running, those results came considerably short of what could be obtained with condensing plant, and they had resolved to this year lay down complete condensing plant, which would still further increase efficiency and reduce the costs.

The resolution was adopted, and the retiring directors and auditors were re-elected, and the chairman, managing director, and staff were thanked for their services.

The Chairman closed the meeting by remarking that whatever of success they now had was due to the foundation which the late Lord Wantage laid.

Chelsea Electricity Supply Co.

The meeting of this company was held at Winchester House on Wednesday last week, Mr. J. Irving Courtenay presiding.

The Chairman, in moving the adoption of the report, said that it was with satisfaction that the directors were able to recommend an increased dividend, notwithstanding that a larger sum had been placed to the credit of renewals and depreciation account than was the case in the previous year, and that a sum of £896 19s. 3d. had been written off the suspense account, which was more than was appropriated in last year's account. The capital expenditure showed an increase of £30,000, but of this only £12,000 had been spent on plant and mains, the remaining £18,000 having been used in completing the purchase of land and property which would be required for extending their principal generating station. It was necessary under the Act to complete last year. The capital expenditure on plant during the year had been small, as they had endeavoured to make the fullest use of their present resources. The mains department had been occupied with a work of considerable importance, namely, the extension of their direct supply mains, which would enable them to deliver to customers in the larger portion of their area direct from the generating works, instead of having to pass the current through a transforming and distributing station. The development of that system had only become possible since lamps suitable for higher pressures had been put on the market, and they hoped in the future to effect considerable economies both in capital expenditure and the distribution losses by taking full advantage of the direct system. Very considerable progress was made during last year in changing over to the 200-volt supply. The earlier customers were originally supplied at the old pressure of 100 volts, and they were in negotiation with those who still remained at that pressure. The alteration of the system had necessitated a considerable outlay during the past year, which had been added to the suspense account, and of that account one-third had been written off. Some further expenses in connection with that change would be incurred this year. The outlay would be well repaid in the future, as the supply at higher pressure would result in a saving of expenditure on the mains. The reduced cost of the supply at 200 volts enabled them also to deliver at a lower price to their customers at that pressure, and they had no doubt that that would lead to the supply being made use of to a greater extent than in the past. The price of coal in 1902 was lower than in the previous year, and a further reduction in the

working costs had been effected. The number of lamps added during the year was 14,971, as compared with 15,754 added during 1901, and the revenue per lamp had improved. The generating plant had been maintained in a state of efficiency, and had worked as well as could be desired. They believed that the steadiness and regularity in their supply of electricity had given general satisfaction to their customers. They were making strenuous efforts to obtain a daylight or power demand, and although Chelsea was not a manufacturing district, they were beginning to meet with some success. There had been a satisfactory extension during the year of the use of their current for motive power; several small workshops and businesses where gas engines and steam engines were formerly employed, had adopted electric motors in place of the other engines with most excellent results. The use of electric lifts in preference to hydraulic lifts in blocks of flats and business premises, was also making steady progress, on account of their superior economy in working. Regarding the amount placed to the depreciation fund, he quoted a paragraph from the report which stated that the amount placed to the credit of the fund was based upon the estimated life of the different plant and property, and although proportionately less than the appropriation of several metropolitan companies, it was considered to be adequate. In conjunction with other electric lighting companies, they opposed the Electric Supply Bill of the London County Council in the last session of Parliament, when the opposition was successful. They would oppose the similar Bill introduced by the Council this session. A question that had been occupying the attention of the directors for a considerable time was the desirability of extinguishing the founders' shares. As they were aware, the founders' shares gave to the holders the right to one-third of the surplus profits of the company after paying 6 per cent. per annum on the ordinary shares, and although that was not an absolute right, but was dependent on the declaration of dividends, it was none the less a charge on the company's undertaking. It was suggested that the founders' shares might be cancelled, and that the holders should, in lieu of their contingent share in surplus future profits, take an immediate share of profits *pari passu* with the ordinary shares. That would get rid of the divergence of interests as between ordinary and founders' shareholders, and would, therefore, if terms satisfactory to both classes could be agreed upon, be for the best interests of the company. That scheme had been approved by counsel in its legal aspect, and they were still in negotiation with the founders on the subject. If they could bring those negotiations to a successful termination, they should approach the shareholders in general meeting to explain the scheme in detail, and ask for their sanction.

Major-General Webber, C.B., seconded the motion for the adoption of the report. An animated discussion followed, several shareholders expressing dissatisfaction with the progress of the company, and the chairman was asked as to the large outlay on land and property.

In reply the Chairman said that it was necessary to purchase the land as the Act compelled them to complete last year. They could not buy a piece of land and erect part of a station, and then buy another piece and erect another part, but must purchase the whole of the land they required at one time.

The report was adopted.

On the motion for the re-election of the auditors, considerable discussion took place, the Chairman saying in reply to a question that the balance-sheets of all electrical companies were submitted to the Board of Trade auditors.

The auditors were ultimately re-elected, and the retiring directors having been re-elected, the meeting terminated.

South Wales Electrical Power Distribution Co.

The first ordinary meeting of this company was held last Saturday at Cardiff. Mr. Robert Forrest presided. The directors' report showed that the Pontypridd permanent generating station was being actively proceeded with, and the company would be ready to commence a supply of power from this station next summer. The work of construction of two further generating stations, one at Neath and one at Cwmbran, had been commenced. These should also be ready to supply current about the same time. Having regard to the contracts with consumers already completed, and the negotiations proceeding with other probable customers, it was practically certain that these stations will commence work under favourable conditions. The company's area was being actively canvassed, and the directors had felt justified, having regard to the numerous inquiries for power which they had received, in at once proceeding with the erection of semi-permanent stations in other parts of the area so that power can be supplied at an early date without waiting for the completion of the large permanent stations. These temporary stations would subsequently be converted into sub-stations.

The Chairman, in moving the adoption of the report, remarked that the directors hoped to commence the supply of current from their permanent station at Bridgend some time during this month. The buildings at Pontypridd were practically completed; some of the machinery had been already delivered. As regards the bulk of it, delivery will be commenced within the next fortnight or three weeks. They had also, under the powers of their Act of last year, acquired land next door to Messrs. Guest, Keen & Nettlefolds' works, at Cwmbran, and were establishing a semi-permanent station there, another at Neath, and were endeavouring to find land for a station at the north-east of Pontypool, somewhere about Crumlin. In the matter of customers the directors were experiencing the greatest satisfaction. Inquiries for current were coming in to a very considerable extent. Many works were already putting in their plant preparatory to the company's mains being brought within supply distance to them. Some six or seven of the large collieries within the Pontypridd station area were getting ready to take the current. At Bridgend they had some 13 or 14 power customers altogether, and they were also going to supply the two asylums of the Glamorgan County Council and the town itself. At Cwmbran, or from the Cwmbran station, the demand which already existed, or from the works which would be ready to take a supply some time in the summer, was even more pronounced than in any other district. At Neath three or four local authorities had agreements practically completed, and many works were also arranging to put in plant so as to be able to take the company's current as soon as it was ready to be delivered.

Sir Richard Sankey seconded, and the report was adopted.

An extraordinary meeting resolved to create and issue £50,000 of debenture stock (5 per cent.).

South London Electric Supply Corporation.

The directors' report for 1902 shows a steady and satisfactory increase both in the business done and the profits earned. The percentage of total costs to revenue has fallen from 90·4 to 64 per cent. The total receipts for the year amounted to £20,145 11s. 8d., and the outgoings to £13,079 13s. 2d. This improvement has been effected notwithstanding the reduction of average receipts per unit sold from 4·75d. to 4·6d. in pursuance of the board's policy of encouraging the use of electricity by cheapening the rates. After placing the sum of £500 to depreciation, thus raising the depretion fund to £2,533, and writing off a similar amount in reduction of preliminary expenses, there is a balance of £6,026 7s. 3d. Out of this the board recommend the payment of a dividend of £1 15s. per cent., carrying forward a balance of £338 17s. 3d. The directors consider that the amount thus set aside for depreciation to date is sufficient, seeing that the plant and mains have been maintained out of revenue in a high state of efficiency, and that a large part of the plant is only now, on the increased output, coming into use. A very satisfactory feature of the accounts is the reduction in the total costs of generating and distributing the current from £15,880 5s. 6d. in 1901 to £13,079 13s. 2d. in 1902, although 171,162 more units were sold in the last-named year. The total costs per unit sold, which in 1901 were 4·13, show a substantial reduction to 2·86d. for the past year, representing a decrease of over 30 per cent. On December 31st, 1901, current was being supplied to the equivalent of 56,510 lamps of 8 c.p. On December 31st, 1902, there were 72,601 lamps connected, being an increase of 28 per cent. At the present time the number is 76,600 lamps of 8 c.p., and applications are in hand for a further 4,800 lamps. A meeting between representatives of the Lambeth Borough Council and this company was held on May 21st last, with a view of arriving at an amicable settlement of the differences existing, but so far no settlement has been arrived at. The erection by the London County Council of their generating station on this corporation's premises is now rapidly approaching completion, and it is expected that the company will shortly be called upon to give the supply of power provided for in the agreement mentioned in the last report. This will add materially to the company's income during the present year.

Hove Electric Lighting Co.

The report for 1902 states that the net profits have increased from £8,282 in 1901 to £10,043 in 1902. After deducting debenture interest paid and accrued, and the interim dividend at the rate of 7 per cent. per annum paid in October last, there remains a net balance of £6,638 to the credit of net revenue account. £2,500 is to be placed to the reserve, a dividend at 10 per cent. per annum for the half-year to be paid, making 8½ per cent. for the year. £500 is placed to maintenance reserve account, and the balance, £429, is carried forward. The reserve fund will amount to £24,326.

The directors have issued during the year £11,370 additional 4 per cent. debenture stock, which at December 31st last stood at £29,070. The amount, £600, annually set aside for repairs and maintenance in accordance with the contract with the Hove Corporation, has proved insufficient to meet the necessary outlay on this account during the year. The excess, £288, has been taken from the maintenance reserve account, which fund, with the £500 now proposed to be added, will stand at £975. Of this amount £900 must be placed to the credit of the capital account to provide for replacement when required of a portion of the original accumulators which has become unserviceable. Expenditure on capital account during the year has amounted to £17,465. Of this amount £10,416 has been expended on land and buildings, £3,322 on extensions of mains, £2,705 for machinery and tools, £856 on meters. The new generating station has been erected, and is rapidly approaching completion. It is expected that the first supply of current from the new station will be made next autumn. Since 1898 the company, with the approval of the Hove Corporation, has been supplying all new consumers at a pressure of 220 volts, and a considerable number of the old consumers at 110 volts have changed over to the higher pressure. It is, however, in the interests of the consumers and of the company that the pressure of supply should be uniform throughout the system, and efforts have been made by the directors to induce the small percentage of consumers still on the 110 volts to change over, but for some reason which the board does not understand the proposals have met with strenuous opposition from the Hove Corporation. The directors have therefore considered it necessary to apply to the Board of Trade for a compulsory order for the change, and an inquiry was held by an inspector of the Board of Trade at the Town Hall, Hove, on December 20th last.

Poole and District Electric Traction Co.

The directors' report for 1902 says that the additional outlay on capital account has amounted to £8,904 17s. 6d., and the total capital expenditure to date now stands at £64,671 5s. 4d. The

total receipts from January 1st to December 31st, 1902, amounted to £13,601 13s. 3d., and the expenses, including £258 17s. 8d. for loan interest, to £9,429 7s. 2d., leaving a net profit of £4,172 6s. 1d., to which should be added £1,787 0s. 5d. brought from last account, making £5,959 6s. 6d. available for distribution, which is to be applied as follows:—Depreciation and reserve fund, £1,000; dividend at the rate of 8 per cent. per annum, £4,000; carried forward, £959 6s. 6d.: = £5,959 6s. 6d.

Notwithstanding that the weather during the past year has not been favourable to tramway traffic the receipts have increased. From April 6th to December 31st, 1902, the cars carried 135,028 more passengers than were carried from April 6th (the opening day) to December 31st, 1901. The number of short-distance passengers has largely increased. Since December 19th last, when the Bournemouth Corporation tramways were opened to the County Gates, the receipts on the company's line have increased and are steadily improving. Six new cars were put into service last August, making a total of 17 cars.

In March last the company successfully opposed the Bill by which the Bournemouth Corporation sought powers to construct an extension along Park Wood and Woodside Roads at Pokesdown, in competition with the company's tramway No. 4, authorised by the Christchurch and Bournemouth Tramways Act, 1900. The Board of Trade have confirmed the order authorising the extension of the Poole light railway from Bourne Pottery through Lower Parkstone, joining the present line again at Park Gates East. Along this route of nearly two miles a feeder cable has already been laid, and is being used in connection with the existing line. In order to safeguard the interests of the shareholders it was necessary for the directors in March last to institute an action against the Corporation of Bournemouth. The present position is that the unanimous decision of the Court of Appeal has been given in favour of this company, but the Court of Appeal has suspended the injunction granted against the Corporation pending an appeal to the House of Lords. The Corporation have given notice of appeal, but negotiations have taken place between the Corporation and the company which have resulted in a provisional agreement for purchase by the Corporation of the whole of the undertaking of the company on terms to be settled by arbitration, and a Bill is being promoted in the present session of Parliament to authorise the Corporation to carry this agreement into effect. Meanwhile the appeal to the House of Lords is by mutual consent suspended.

Pending the hearing of the Christchurch and Bournemouth Tramways Bill promoted by the Corporation of Bournemouth, the construction of these tramways is not being proceeded with. The company has deposited a Bill in Parliament for powers to extend the time for the completion of these tramways, and also to authorise the extension of the Poole Light Railway to Poole Quay.

The Metropolitan Electric Supply Co.

The directors' report for the year ending December 31st, 1902 shows that the capital expenditure, which at the end of 1901, amounted to £1,619,731 2s. 8d., has now reached a total of £1 846,448 4s. 10d., being an increase during the year 1902 of £226,717 2s. 2d. The principal items of expenditure were for the works at Willesden, and for the extension of the low-tension system, chiefly in Marylebone. The gross revenue for the year amounted to £261,073 4s., as compared with £235,741 18s. 11d. in 1901, being an increase of £25,331 5s. 1d. The cost of generation, which in 1901 was £112,610 10s. 3d., amounted in 1902 to £113,746 17s. 6d., or an increase of £1,136 7s. 3d. The second system of extra high tension mains from Willesden to certain of the town stations is being laid under the powers conferred upon the company by their Act of 1901. The arbitration held under the provisions of the Electric Lighting Order Confirmation (No. 1) Act, 1901, to determine the purchase money and compensation to be paid to the company by the Borough Council of St. Marylebone for the acquisition by them of the company's Marylebone undertaking and business has resulted in the company being awarded the sum of £1,212,000 as at December 31st, 1901. This sum does not include capital expenditure in Marylebone from that date until the date of transfer, which the company claim to be reimbursed. Negotiations are taking place with the Borough Council on this subject, and as to the price to be charged for the supply of energy from Willesden. Pending completion of the purchase no change has been made in the form of the accounts, which are subject to re-adjustment when that event takes place. On receipt of the purchase money the directors will prepare and submit to the shareholders a scheme for dealing with it. The arrangement with the company's bankers referred to in last report, under which current capital requirements are provided for by temporary loans, has been continued and extended so as to provide for the outlay necessary during the next few months. If undue delay takes place in the payment of the Marylebone purchase money, it will be necessary that the directors should be empowered to issue further capital to repay these loans, in which case an extraordinary general meeting will be called for that purpose. The arbitration under the terms of the London County Council (Improvements) Act, 1899, in connection with the compulsory acquisition of the generating works at Sardinia Street is in course of hearing. The balance at the credit of the revenue account, before providing for depreciation, is £108,784 7s. 9d. The directors have set aside £10,000 as an addition to the depreciation and reserve fund, which now amounts to £98,447 5s. 10d., carrying to the credit of the net reserve account (No. 5) the sum of £98,784 7s. 9d., which, with the balance brought forward from last account and other receipts, makes a total of £103,070 16s. 9d. After deducting interest on debenture stock and loans and other charges, there remains a balance of £73,873 12s. 4d. An interim dividend of 7s. per share on the ordinary share capital was paid on August 12th, 1902, amounting to £35 000, and the directors recommend that a further dividend of 7s. 6d. per share on such shares be now paid, making a total distribution of 14s. 6d. per share, being at the rate of 7¼ per cent. for the year. This will absorb a further sum of £37,500, and leave a balance of £1,373 12s. 4d. to be carried forward to the next account. The number of 8-c.p. power lamps supplied by the company increased during the year from 641,000 to 723,000. The present number of lamps connected is 740,000, and the applications show no signs of decrease. The stations, machinery and plant have been maintained in a satisfactory condition.

Potteries Electric Traction Co.

The directors' report for the year 1902 says that the gross receipts for the year amounted to £9,343 5s. 8d. After deducting all expenses chargeable to revenue, including repairs and maintenance, and interest on loans and debenture stock, there remains a net profit of £23,298 7s. 10d. £258 10s. 2d. was brought forward, and the available balance of £23,557 8s. is to be applied as follows, viz:—

To provide for the dividend for the year on the 5 per cent. cumulative preference shares	£10,353	3	0
To pay a dividend on the ordinary shares of the company at the rate of 5 per cent. for the year	10,353	3	0
To transfer to the credit of depreciation and reserve fund	2,000	0	0
To carry forward to next account	851	2	0
	£23,557	8	0

The report continues:—

The weather during the past year has been very unfavourable to tramway traffic, nevertheless the traffic receipts during the year have increased by about £6,000, or 8 per cent., chiefly owing to the improved services. Further economies have been effected in the running expenses, but this advantage is lost, to a certain extent, by the large increase that has taken place in the amounts paid for rates and insurance. In completion of the arrangements made for the acquisition by the company of the whole of the issued debentures of the North Staffordshire Tramways Co., the remaining £150 debentures have been purchased. The company has also called upon the North Staffordshire Tramways Co. to issue the remainder of the first and second debentures due to the company under agreements for the electrical equipment of the North Staffordshire Tramways, and the company now holds the whole of the authorised debentures in that company. In order to provide for extensions of plant, &c., referred to in the last report, the directors called up, during the year, the balance unpaid on the ordinary and preference shares issued in May, 1901. The capital expenditure during the year amounted to £33,172 4s. 10d., which, added to the sum previously expended on the construction and equipment of the lines, &c., amounts to £448,6?9. To this must be added £223,0?9, the cost of shares and debentures of the North Staffordshire Tramways held by the company, making the total capital expenditure on the undertaking £671,698. The directors regret that owing to the protracted negotiations with the Stoke Corporation, which extended throughout the year, they have been unable to commence the construction of the light railway between Newcastle and Stoke authorised by the order of 1902. The express parcels delivery service, which was put into operation towards the end of the year 1901, is well patronised, and it is anticipated that this year's working of the department will result in a profit. Applications have been received from local authorities and others for the extension of the tramway system into parts of the district not yet served by the company. The Bill promoted jointly by the North Staffordshire Tramways Co. and this company has now received the Royal Assent. Mr. C. S. Drummond has retired from the board owing to other engagements.

	1901.	1902.
Miles open—		
Route miles	28·95	28·95
Single line	22·95	22·95
Double line	6·0	6·0
Number of passengers carried	13,361,778	14,438,048
Average traffic receipts per passenger	1·83d.	1·92d.
Average expenditure per passenger	0·88d.	0·78d.
Proportion of expenses to receipts	62 p.c.	59 p.c.
Number of cars in stock	105	105

Hart Accumulator Co., Ltd.

Mr. G. W. Kidd presided at the annual meeting, held at Stratford on 4th inst., and in moving the adoption of the report, he said that the company could well afford the 15 per cent. dividend that it was paying. It had been earned in a year of great competition. A number of German companies were trying to get into the battery world in England, and they were taking orders or quoting at a price for which they could hardly buy the lead. Few of them, however, had succeeded. The dividend had been earned by curtailing the expenses of manufacture, the introduction of new labour-saving machinery being a great help in that direction. The sale of their lighting type of battery increased by double last year, as compared with the year before. After two years of experimenting they had designed a plate worthy of being put on the market for motor-car work, and were fairly engaged on that class of work now. Bigger works were necessary, and large adjoining premises had been obtained. New capital might have to be raised for rebuilding these for the purposes of the company. They were retaining the services of their manager, Mr. E. J. Clark, for a further period of seven years. The report was adopted.

Prospectuses.—The prospectus of the Yorkshire Electric Power Co. has been issued. The nominal capital of the company is £2,000,000, of which sum £430 000 in £10 shares at par forms the present issue. Mr. H. F. Parshall is the consulting engineer, and he estimates the total cost of the first portion of the undertaking at £519,000. Four generating stations are provided for, namely, at Mirfield (which will be the first to be equipped), Methley, Wath, and Bingley—these all being, with the exception of the last-mentioned, situated in colliery districts. The total area of supply is 1,800 square miles with the exception of the central areas of the cities of Leeds and Bradford (enclosed within a mile radius of the Town Hall, and Sheffield—within a similar 1½ mile radius. The list closes on March 19th. Further particulars will be found in our advertisement pages.

The Gravesend and Northfleet Electric Tramways, Ltd., is inviting subscriptions for £40,000 4½ per cent. first mortgage debentures, also 37,500 6 per cent. preference, and 17,460 ordinary shares of £1 each.

Baker Street and Waterloo Railway Co.—The report for the half-year ended December 31st last states that capital expenditure during the half-year amounted to £96,713. The estimated expenditure for the current half-year is £185,000. The engineers' report states that 80 per cent. of the whole length of tunnelling on the contract, Waterloo to Dorset Square, has been

driven, and all station tunnels constructed except one at Waterloo, and the enlargement of the running tunnels for two at Regent's Park station. With reference to the Elephant and Castle extension, the contractors have started the excavations for the depôt on the site of the old Blind School, and are preparing to start the tunnelling from a shaft to be sunk on that property.

Melton Mowbray Electric Light Co.—The fourth annual general meeting was held at the works last week, Mr. W. J. New presiding. The progress during the year had been satisfactory. Including the balance of £462 brought forward from the previous year's account, the net revenue amounted to £1,213 12s. 11d., which, after paying debenture and loan interest amounting to £714, left a balance of £499 available for distribution. A dividend was declared of 2½ per cent., absorbing £201, and the balance of £298 is carried forward. There was due to various contractors at the end of the year £13,781 18s. 6d. For the purpose of paying off this amount and providing capital for further extension, it was proposed to increase the capital of the company. At a subsequent meeting, a resolution was adopted approving of the creation of 3,000 new shares of £5 each, and authorising the directors to borrow sums of money not exceeding £10,000.

Liverpool District Lighting Co.—The report for 1902 states that the demand for electric light in the district continues to show a satisfactory increase, the number of lights connected to the supply mains during the year being 1,752, making the total number installed at January 1st, 1903, 10,656. It was decided to lower the rate from July 1st, 1902, 1d. per unit, the number of lamps connected at that time having exceeded 10,000. The reduction has been justified by the result of the second half-year's work, the number of units sold exceeding that of the corresponding half of the previous year by nearly 20,000, the revenue having also increased. The total revenue from the sale of electricity has been £3,673, an increase of £570. The contracting business shows a falling off from the previous year. The gross profits for the year are £2,498, and the available profit £3,918; the depreciation fund takes £716, leaving a balance of £3,201. An interim dividend at 5 per cent. per annum was paid for the half-year ended June 30th, and it is proposed to transfer from the sale of the Gateacre undertaking suspense account the sum of £140, and to declare a further dividend at 5 per cent. per annum.

Vickers, Sons & Maxim.—The meeting of this company is to be held at Sheffield next Wednesday. The directors' report says that trade was again in a stagnant condition last year. Other statements in the report include the following:—"The Wolseley Motor-Car Works, mentioned for the first time in last year's report, have given a fair profit on the capital invested, and this the directors confidently hope will be increased now that the organisation for the manufacture of motor-cars on a large scale has been properly developed. The company's motor-cars continue to be very popular. The Electric and Ordnance Accessories Co., Ltd., has not yet reached the profit-earning stage."

Stock Exchange Notice.—The Committee has been asked to allow the following to be quoted in the Official List:—Waygood & Otis, Ltd.—Further issue of 30,000 ordinary shares of £1 each, fully paid, Nos. 105,001 to 135,000; and 30,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 105,001 to 135,000.

Hadfield's Steel Foundry Co.—The directors recommend that, in addition to the interim dividend of 1s. on the ordinary shares, a further dividend of 2s. per share, together with a bonus of 2s. per share be paid; £25,000 is added to the reserve and renewal account, and the balance of £15,165 carried forward. The growth of the company's business has made it desirable to increase the capital of the company to enable the new works at Tinsley to be extended.

District Spanish Telegraph Co.—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent. on the ordinary shares, both for the half-year ended December 31st, 1902.

British Insulated and Helsby Cables.—The directors have declared a final dividend on the ordinary shares of 6 per cent., making 10 per cent. for the year, and have placed £10,000 to reserve.

Commercial Cable Co.—A quarterly dividend of 2 per cent. is payable on April 1st.

County of London and Brush Co.—Final dividend (last half of 1902) at 4 per cent. per annum, making 4 per cent. for the year.

STOCKS AND SHARES.

Wednesday Evening.

Since Consols touched the lowest price on Tuesday that they have seen for over 30 years, it is not to be supposed that there will be very exhilarating news to chronicle in regard to investment markets generally. The decline in Home Railways has been accompanied by a sharp Yankee slump, while speculation in mining shares is well-nigh dead for the time being. Money inclines to stiffness, although there is a fairly plentiful supply on offer when tempting rates are bid; and so long as the Americans can avert a panic in Wall Street, one may feel safe in saying that the general weakness now current will probably prove to be but temporary.

Electrical Supply shares, however, stand out in keenly-marked contrast so far as the prevailing dulness of prices is concerned. In fact, there is not a single decline to report, while rises are both numerous and substantial. Of course, there is nothing in the nature of a boomlet in electric lighting shares; it would be greatly to the market's ultimate disadvantage if there were. Business is good, and solid investment demand makes itself evident in the gradually improving quotations. A feature is the way in which some of the lower-priced shares are been hauled out for attention. London Electric Ordinary and Preference, for example, are both much better on the week, as are also Smithfield Ordinary, which have regained their loss of last week. Smithfield Debenture, on a very small amount of buying, spurted nearly six points, and stands but little short of 90.

Metropolitan Electrics have hardened half a sovereign, notwithstanding the uncertainty that must necessarily continue for some time to come as to whether the arbitration money can and will be paid, and how. In view of this unsettlement (while it is generally thought in the Stock Exchange that the company will get its money), the suggestion may be advanced as to the advisability of holding the shares while the matter remains in abeyance. It is, at all events, a point worth considering whether an exchange into shares paying a higher rate of interest is not commendable. Metropolitans yield about 3½ per cent. on the money at the present price, but Charing Cross Ordinary return over 5 per cent, and the likelihood of investors choosing Charing Cross shares by reason of their good return must be taken into consideration. Naturally, there are arguments in favour of holding Metropolitans, but we would point out that possibly money invested in the shares might be utilised to better advantage in other directions. Charing Cross Prefs. are ¼ up.

On former occasions we have mentioned that negotiations were in progress for the formation of several large electrical power companies on somewhat similar lines to those pursued by the South Wales Electrical Power Co. Incidentally it may be remarked that 500 shares in the South Wales undertaking changed hands the other day at 5s. discount. At least two of the new power concerns have got as far as the preliminary prospectus stage, and it is no betrayal of confidence to mention that both of these are intended to operate in the North of England. A very fancy article in the way of private issues is that of an electrical boat company, in which several powerful Stock Exchange firms have interested themselves.

Dublin Tramway Ordinary shares are a better market at 13½ on the understanding that an annual claim made by the Corporation on the company is indefensible and need not be paid. Expert advice has been taken, and a meeting held in London to discuss the question. If what is said as to the illegality of claim be correct, Dublin Tram shares should receive an increased dividend of some 2 per cent., which is a consideration. London United Preference are 11½, and the Debenture stock about 107¼. Calcutta Trams have been done at 7¼ and 7$\frac{9}{16}$, North Metropolitans at 3⅜, during the past few days. British Electric Tractions are slightly better as regards the Ordinary, but the Preference remain unaltered; in which connection it may be pointed out that the new British Electric Traction Preference are about 10s. a share cheaper than the old, and as the difference will right itself automatically in favour of the new, the latter should, of course, be chosen by intending buyers. Westinghouse Ordinary shares are 7½, and the Preference 6¼ middle.

Brush Electrical shares of both classes are better, although the First Debenture stock has shed a brace of points. What the movement in the shares portends is impossible to say just now, but shrewd prophets wonder whether it is connected in any way with fresh developments akin to the latest carried out with regard to this company and the British Electric Traction. Insulated Wire shares have improved in each case.

The fall in Home Railways has produced slight effect amongst electrical stocks. Central London Ordinary yielded a point, and the Debenture is 1 up, but otherwise there is no recordable change. Details of the Baker Street and Waterloo Railway Co.'s report appear in another column. The shares in this white elephant are scarcely ever heard of in the market.

In the Telegraph department Direct United States Cable shares have been pressed for sale and are flat, while the Anglo-American trio are all cheaper. Submarine Cables Trust certificates have lost their $5 rise of last week, but the Eastern varieties are unaltered. The progress of Marconi is watched with unpleasant interest by the market. No change has occurred in the prices of the Globe Telegraph and Trust Co.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Mar. 4th.	Closing Quotations Mar. 11th.	Business done week ended Mar. 11th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	97 —101	97 —101	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½— 3½	2½— 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,950 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	61s.	60/6	49 — 52	48 — 51	50½	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 94	91 — 93	92½	91
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	8½— 8¾	8 — 8⅛	8⅛	8
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4 — 4½	4 — 4½	4⅛	..
13,333,300§	Commercial Cable	$100	8 %	8 %	..	160 —170	160 —170	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	90 — 93	90 — 93	93	90½
16,000	Cuba Telegraph	10	4½%	4 %	..	6¼— 7¼	6¼— 7¼	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13½— 14½	13½— 14½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2½— 3½	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	10 — 10½	9 — 10	..	..
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	122 —127	122 —127	124	122
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	86 — 89	86 — 89	86	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	107⅜	106½
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	11¼— 12¼	11½— 12¼	11⅝	11½
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	98 —101	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 3,000	25	..	..	..	101 —104 %	101 —104 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8¾— 9¼	8¾— 9¼	9	..
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 13	12 — 13	12⅝	12
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	..	25 — 27	25 — 27	..	..
66,800£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	..	37 — 41 xd	37 — 41	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	100 —104	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	2½%	..	⅞— 1	⅞— 1	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	..	..	..	⅞— 1	⅞— 1	..	..
1,993,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	97 — 99	97 — 99	98½	97
1,966,667	Do. do. Def. Stock	100	..	..	4½%	69 — 71	70 — 72	72	69½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	13½	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	12⅝	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5⅛— 5⅜	5⅜	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 98	96 — 98	97⅛	96⅞
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	101 —103	101 —103	102½	102½
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞— 1	⅞— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	5 %	..	6¾— 7¾	6¾— 7¾	..	..
3,803	Submarine Cables Trust	Cert.	..	..	..	110 —120	105 —115	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾— 6⅞	5¾— 6⅞	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¾— 5¼	4¾— 5¼	5⅛	5
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	103 —106	103 —106	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	96 — 99	96 — 99	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 267,980	10	7 %	7 %	..	11 — 12	11 — 12	11⅜	11½
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	97 —100	97 —100	98½	97
88,321	West India and Panama Telegraph	10	2%	..	..	⅝— ¾	⅝— ¾	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6½— 7	6½— 7	6⅛	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4 — 5	4 — 5	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
300,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	9 %	9 %	..	13 — 14	13½— 14	13⅝	13½
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12½	12 — 12½	12½	12⅜
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	124 —127	124 —127	126½	126
100,000	British Insulated Wire Ord.	5	15 %	10 %	..	7¾— 8	7¾— 8	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —106	102 —106	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	16/6 to 17s.	16/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	..	¾— 1¼	1 — 1½	1⅛	1
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	..	1 — 1½	1 — 1½	1½	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	101 —104	99 —102	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	91 — 96	91 — 96	..	..
85,000	Callender's Cable Construction shares	5	15 %	20 %	..	13½— 14½	13½— 14½	14	13¹³/₁₆
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 6	5½— 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	105 —109	105 —108	106½	106¼
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	103 —106	103 —106	105⅛	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	109 —113	108 —111	..	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	76 — 77	76 — 77	76⅜	75
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	..	2½— 3	3½— 3	2½	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	102 —106	102 —106	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	⅝— ¾	⅝— ¾	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1½— 2½	1½— 2½	..	..
844,923£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	73½	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1½— 2	1½— 2	1⅝	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2½— 3	2½— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	100 —103	100 —103	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	15½— 16½	15½— 16½	16⅛	16
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5¼— 5⅝	5¼— 5⅝	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111 xd	107 —111	109	108½
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18½— 19½	18½— 19½	18⅝	18½
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	101 —104	101 —104	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5¾— 6¼	5¾— 6¼	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10¾— 11	10¾— 11	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14¼— 15½	14¼— 15½	..	..
37,850	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	38 — 41	38 — 41	40½	39
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	97 —100	97 —100	..	..

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.

‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅞—1.
National Electric Free Wiring, ⅛—¼.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Mar. 4th.	Closing Quotations Mar. 11th.	Business done week ended Mar. 11th, 1903. Highest.	Lowest.
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	1	..	..	..	⅜ — 1	⅜ — 1	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	115 —118	115 —118	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	8 %	8 %	10¼— 10⅝	10⅜— 11	10⅝	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	10 — 10⅛	10 — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9¼	9 — 9¼	9⅜	..
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛— 5⅜	5¼— 6	5¼	5⅛
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4¼— 5¼	4¼— 5¼	4⅛	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	104 —106	105	..
44,436	†Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	6 — 6¼	6 — 6¼	6⅜	6¼
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	108 —111	108 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	5 %	10 — 11	10 — 11	10¼	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13¾— 14½	13¾— 14½	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	102 —105	103 —106	104⅜	104½
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	..	9 — 10	9 — 10	9⅝	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	..	..	12 — 13	12 — 13	12⅝	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	..	..	..	..	109 —112	109 —112	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6¾— 7	6¾— 7	..	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅜	6 — 6⅜	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	106 —109	106 —109	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10¾— 11⅛	10¾— 11⅛	..	..
90,000	Do. do. 4 % Debenture Stock	Stock	..	..	..	100 —103	100 —103	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2⅛— 2⅜	2⅛— 2⅜	2⅜	2 1/16
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅝— 6	5⅝— 6⅛	6	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	100 —103	100 —103	101⅛	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6½%	7½%	18 — 19	18½— 19	19	18⅝
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	108 —113	108 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	98 —101	98 —101	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	14½— 15½	14½— 15½	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	15 — 16	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	..	8½— 9⅛ xd	8½— 9⅛	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	97 —100	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	2 — 2½ xd	2½— 3	..	..
50,000‡	Do. do. 4% Deb.	100	..	..	..	80 — 90	86 — 91	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	1¾%	3⅛— 3⅜	3⅛— 3⅜	..	..
30,000	Urban Electric Supply, Ord.	5	..	..	..	4¼— 5⅛	4¼— 5⅛	5 1/16	5
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4¼— 5⅛	4¼— 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13 xd	12 — 13	12⅝	12¼
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6¼	6 — 6¼	6¼	6¼

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, March 11th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	,, Nitric	per cwt.	22/-	..
a	,, Oxalic	per cwt.	32/-	..
a	,, Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal)	per ton	£38 10	..
a	,, ,,	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£18	..
a	Benzole (90 %)	per gal.	7/-	..
a	,, (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£23 15	..
a	Lead, Nitrate	per ton	£24	..
a	,, White Sugar	per ton	£31	..
a	,, Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks	per lb.	4d.	..
a	,, Caustic (75/80%)	per ton	£24	..
a	,, Bisulphate	per ton	£35	..
a	Shellac	per cwt.	119/-	..
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers	per ton	£6 5	..
a	,, Recovered	per ton	£5 10	..
a	,, Lump	per ton	£5	..
a	Soda, Caustic (white 70 %)	per ton	£10 15	..
a	,, Crystals	per ton	£3	..
a	,, Bichromate, casks	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots	per ton	£148	..
b	,, Wire, in ton lots	per ton	£224	..
b	,, Sheet, in ton lots	per ton	£191	..
p	Babbitt's metal ingots	per ton	£42 to £143	inc.
c	Brass (rolled metal 2' to 12') basis	per lb.	7d.	½d. inc.
c	,, Tube (brazed)	per lb.	9d.	½d. inc.
c	,, ,, (solid drawn)	per lb.	7¾d.	½d. inc.
c	,, Wire, basis	per lb.	7¾d.	½d. inc.
c	Copper Tubes (brazed)	per lb.	9½d.	½d. inc.
	,, ,, (solid drawn)	per lb.	9¾d.	½d. inc.
	Copper Bars (best selected	per ton	£78	£5 inc.

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£78	£5 inc.
g	,, Rod	per ton	£78	£5 inc.
e	,, (Electrolytic) Bars	per ton	£65 10	£2 inc.
e	,, ,, Sheets	per ton	£79	£2 inc.
e	,, ,, Rod	per ton	£68 10	£2 inc.
e	,, ,, H.C. Wire	per lb.	8¾d.	½d. inc.
f	Ebonite Rod	per lb.	3/-	..
f	,, Sheet	per lb.	5/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	3/9½ to 3/11	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	,, Pig (Cleveland warrants)	per ton	50/11	11d. dec.
i	,, Forgings, according to size	per ton	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	..
i	,, Wire, galvanised No. 8	per ton	£9 15	..
g	Lead, English Ingot	per ton	£13 12 6 to £13 15	18/9 to £1 inc.
g	,, ,, Sheet	per ton	£13 2 6	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£8 12 6	..
d	Mica (in ginal cases) small	per lb.	3d. to 9d.	..
d	,, ,, ,, medium	per lb.	1/9 to 2/9	..
d	,, ,, ,, large	per lb.	3/9 to 7/8	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2	..
p	,, rolled bars & rods	per lb.	1/- to 1/8	..
p	,, ,, strip & sheet	per lb.	From 1/2	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	9½d. to 1/-	inc.
i	Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	,, ,, in bars	per ton	£15 to £40	..
g	Tin, Block	per ton	£141 to £142	£1 inc.
g	,, Foil	per lb.	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/10	1d. inc.
p	White Anti-friction Metals— "White Ant" brand	per ton	£42 to £62	inc.
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7½d.	..
j	,, 6 lea. Flax	per lb.	5½d.	..
j	,, 3 ply 10 lbs. Russian	per lb.	4½d.	..
j	,, 10 lbs. Russian, single	per lb.	4½d.	..
j	,, 180 lbs. Jute rove	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£25 15	£1 inc.

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons., Ltd. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys.	Mar. 7	699	— 20	35,997	+ 4,712	12½	13½
Blackpool and Fleetwood	,, 7	202	+ 3	1,811	+ 290	7½	7½
Bristol Trys. & Car. Co.	,, 6	4,212	—670	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley District	Feb. 27	158	—	1,282	—	—	—
Devonport	,, 27	357	+ 50	8,095	+ 22	5	5
Dudley—Stourbridge	,, 27	696	+ 75	5,566	+ 605	18½	18½
Gateshead	,, 27	830	+224	6,669	+ 1,549	10½	9½
Gravesend—Northfleet	,, 27	174	—	1,409	—	3½	—
Greenock—Pt. Glasgow	,, 27	381	+ 47	3,261	+ 360	7½	7½
Hartlepool	,, 27	521	+ 50	1,767	+ 378	6½	4½
Kidderminster	,, 27	98	+ 12	803	+ 80	4½	4½
Merthyr	,, 27	175	— 8	1,373	— 140	3	3
Middleton	,, 27	199	—	1,108	—	8½	—
Oldham—Ashton	,, 27	5 1	+ 36	4,188	+ 509	8	8
Peterborough	,, 27	109	—	696	—	—	—
Poole	,, 27	219	+ 53	1,836	+ 417	8½	8½
Potteries	,, 27	1,561	+187	12,181	+ 1,159	28½	28½
Rothesay	,, 27	35	+ 8	381	+ 90	—	—
B.E.T. Co. (*continued*)—							
Southport	Feb. 27	102	+ 76	1,726	+ 740	5½	5½
South Staffordshire	,, 27	709	— 11	5,501	— 214	21½	22½
Swansea	,, 27	436	+ 35	3,563	+ 310	5½	6½
Taunton	,, 27	51	— 3	394	— 23	1½	—
Tynemouth	,, 27	214	+ 53	1,674	+ 219	3½	3½
Weston-super-Mare	,, 25	27	—	196	—	2½	—
Wolverhampton Dist.	,, 27	354	+210	2,737	+ 1,585	10½	4½
Yorkshire Wollen Dist.	,, 27	127	—	188	—	6	6
Central London Railway	Mar. 7	6,978	+220	69,615	+ 3,498	6½	6½
City and S. London Ry.	,, 8	2 288	+167	32,716	+ 2,245	5½	—
Dover Corporation Trys.	,, 7	183	— 17	1,686	+ 26	3	3
Dublin United Trys.	,, 6	4,203	+ 89	39,456	+ 2,541	46	46
East Ham Tramways	,, 7	480	+142	18,148	+ 4,462	5	4½
Glasgow Corp. Trys.	,, 7	12,128	+2,363	489,275	+14,293	69	60½
Liverpool Overhead Ry.	,, 8	1,494	+ 93	14,832	+ 1,223	6½	6½
Newcastle Corp. Trys.	,, 7	2,991	+1,100	—	—	25	—
Sunderland Corp. Trys.	,, 8	971	— 43	—	—	17½	17½

* Compared with the corresponding period of 1901.

THE MURRAY PRINTING TELEGRAPH.

Since the adoption of the Wheatstone system of telegraphy by the British Post Office authorities, the untiring energy which has from time to time been devoted by the department's officers to improvements in the detail of the apparatus, has resulted in this system being brought to an extremely high degree of excellence, so that on long circuits the speed is practically limited only by the capacity and the resistance of the wire connecting the terminal stations. It is recognised, however, that when a reduction of wires between two centres (caused by breakdowns) takes place, and when, in consequence, it becomes imperative to change from ordinary Morse hand-signalling to the high-speed Wheatstone apparatus (in order that advantage may be taken of the full capabilities of the channels available for traffic), then the transcription of the received slip causes considerable delay in the ordinary telegram traffic.

To overcome this difficulty, Mr. Murray (who, by the way, is a Scotchman by descent, a New Zealander by birth, and has spent many years in Australia as a journalist), has attempted to combine high speed of signalling with prompt transcription at the receiving station. In addition to this important combination, the apparatus has been designed with a view to reducing to a minimum the skilled labour necessary for working the Morse, Wheatstone, and other systems of telegraphy.

General Principle of the System.—As in the Wheatstone method of working, a perforated slip in connection with a transmitter is employed for signalling purposes. The received signals perforate a slip, which in turn is inserted in a hand-worked machine termed a printer. The mechanism of this printer actuates the strikers of a specially adapted Barlock typewriter, and produces clear, bold, capital letters, figures, and other characters usually signalled by telegraph.

Murray Alphabet.—By using multiple units of current and space (that is, by using several different time intervals instead of only one), Mr. Murray preserves the ideal simplicity of the Morse alphabet with the additional advantage of securing letters of the same length. From the facsimile of a transmitting tape showing the Murray alphabet, given later, it will be observed that the uniform time for each letter is divided into five equal units or sub-divisions, one or more of which represents a current impulse, so that the signals transmitted to line may have a duration of one, two, three, four, or five units. By this arrangement it is possible to obtain 32 distinct combinations, and by using two of these letter signals as prefixes to the others, capitals, figures and other characters may be obtained. No space is necessary between the letters, as in the Wheatstone system, in fact, signals in adjoining letters frequently coalesce. Each character occupies a space of half an inch on the tape, denoted by a cross line at equal intervals throughout the roll, and for feeding purposes the slip is prepared previous to use. In cases where necessitate the use of a repeater, the ordinary repeating apparatus with centre-hole perforations the requirements of a wire

employed for this purpose in connection with Morse and Wheatstone circuits will, of course, be suitable for the Murray system.

Before describing the working of the circuit, it will be necessary to explain the function of the different pieces of apparatus employed.

Description of Apparatus.—Diagrams of the actual connections for duplex working are shown in figs. 1 and 2. A Wheatstone

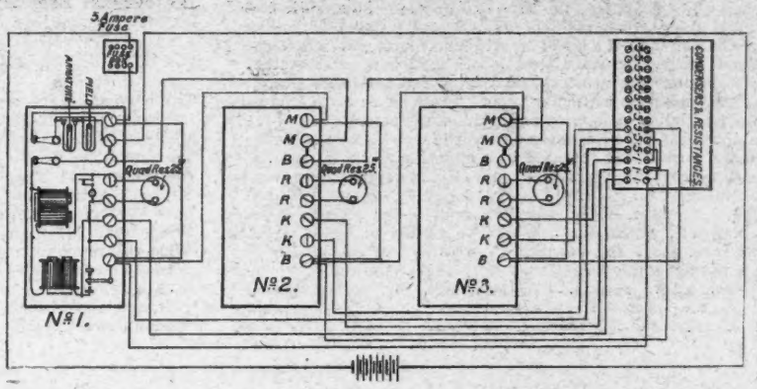


Fig. 1.

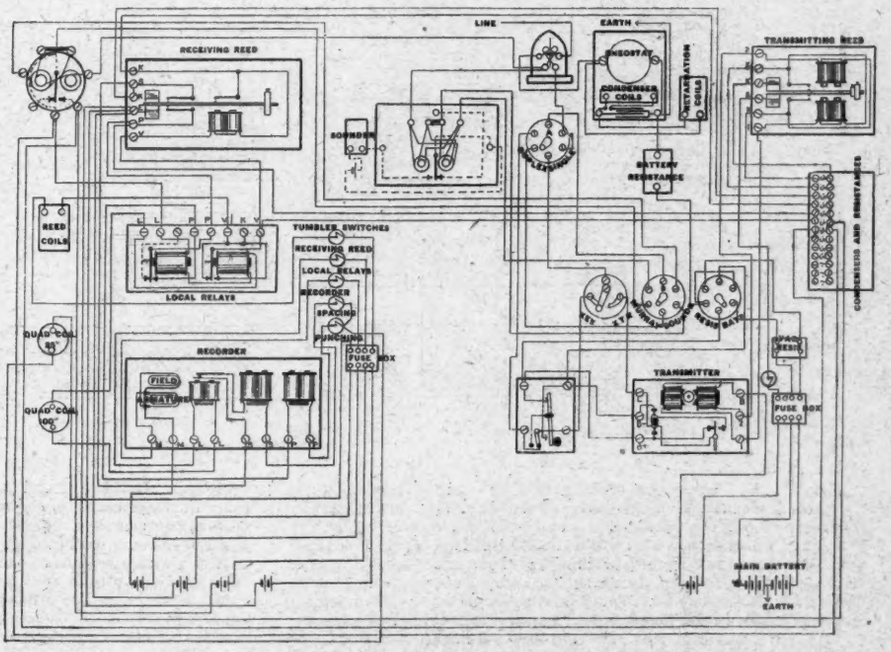


Fig. 2.

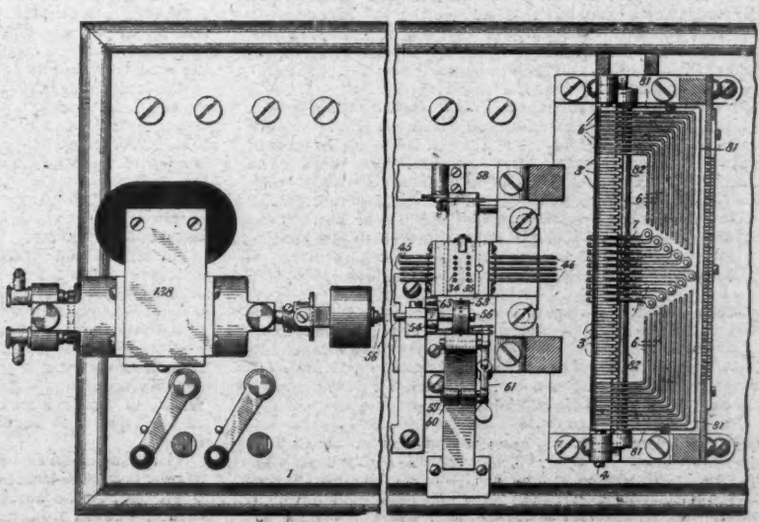


Fig. 3.

receiver, a key, and an ordinary sounder, are included, so that Morse working may be resorted to, if desired, by means of the switches inserted for this purpose.

The Perforator.—A keyboard similar to that of a typewriter is employed for preparing the tape for the transmitter. Beneath the key bars are arranged crosswise a series of light steel bars shaped like "fiddlebows." Different combinations of slots are cut on the under surfaces of the key bars, where they rest on the fiddle-bows. In this way, by depressing the keys, one or more of the fiddle-bows in various combinations are depressed. These selected fiddle-bows operate one or more of a set of 10 bell-crank levers, which control an equal number of small steel blocks resting above a group of punches, one or more of which must be operated simultaneously to punch the holes for a particular letter. These punches are arranged in two parallel rows, one on each side of the central line of feed holes previously punched in the tape. The punches are struck by a bell-crank striker bar actuated by a punching electro-magnet. If this electro-magnet is operated when no key is depressed, the whole of the punches will be driven through the paper tape; but if one of the keys is depressed, it selects certain fiddle-bows, which operate certain levers, which, in turn, remove certain of the small steel blocks from above the punches. The striker bar operated by the punching magnet can then actuate only those punches over which the steel blocks remain. In this way, by depressing any one of the keys, it is possible to punch any combination of holes in the required locations in each letter space on the tape. The punches are retracted by small springs when the punching magnet has released the striker bar. The feeding of the tape is effected by means of a small sprocket, or star wheel, the teeth of which engage with the central line of feed holes in the tape. On the same shaft as the sprocket wheel is a small ratchet wheel, connected with which is an anchor escapement controlled by a spacing electro-magnet. The shaft is driven by a small shunt-wound motor in conjunction with a spring-box device. Connected with the circuits of the punching and spacing magnets are two electrical contacts, between which a tongue oscillates. This tongue projects from an additional fiddle-bow operated by all the keys, and normally rests against the spacing contact, closing the latter circuit when in this position. The moment any key is depressed the spacing circuit is broken, and the spacing magnet actuates the escapement, thus allowing the tape to be fed forward a portion of a letter space, one third of the total step. On further depressing the key, it selects the fiddle-bows which remove certain punch blocks from above the punches, and when the key is near the end of its depression it has depressed the additional fiddle-bow so far that the contact tongue projecting from this fiddle-bow touches the punching contact and closes the punching magnet circuit, thereby operating the striker bars which drive the punches through the tape. On releasing the key, the punching circuit is broken and the punches are withdrawn. When the tongue returns to the spacing contact the spacing magnet armature is attracted, and in doing so, feeds the tape forward the remainder of a letter space, viz., two-thirds.

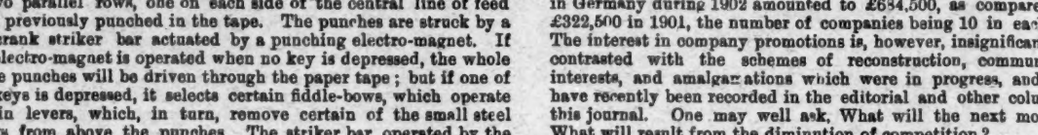


Fig. 4.

Fig. 3 is a broken plan view, and fig. 4 is a sectional side elevation, of the perforator. When a key, 3, is depressed, one or more of the 10 fiddle-bows, 6, are forced down. These depress corresponding kickers, 7, which are arranged beneath the fiddlebows, and the bell crank levers, 12, are in turn actuated, finally causing one or more of the punch blocks, 23, to be withdrawn from over the punches, 34. The tape is inserted in the slit 44, between the punches and die plate, and as a consequence, when the punching magnet, 37, is energised, the bell-crank lever, 30, is actuated, and the universal striker bars, 32, 33, strike down on the punches, but operate only those from which the punch blocks have not been withdrawn. In this way, by depressing various keys, it is possible to operate any combination of one or more punches required for perforating the tape to represent a letter. On releasing the key it is drawn up to its normal position by the spring, 25, and the kickers are retracted by their springs, 26, thus replacing the fiddlebows and the punch blocks. The punches are at the same time retracted by their springs, 45, 46.

(To be continued.)

THE GERMAN ELECTRICAL INDUSTRY.

Improvement Expected from the Mining and Iron Trades. The Conclusion of Two Large Contracts.

The nominal capital of the electrical companies which were formed in Germany during 1902 amounted to £634,500, as compared with £322,500 in 1901, the number of companies being 10 in each year. The interest in company promotions is, however, insignificant when contrasted with the schemes of reconstruction, community of interests, and amalgamations which were in progress, and which have recently been recorded in the editorial and other columns of this journal. One may well ask, What will the next move be? What will result from the diminution of competition?

In the meantime it is said that employment in the electrical trade is at present slightly better than at the corresponding period of last year, and the relatively more favourable news from the iron and steel districts has stimulated hopes of improved times for electrical engineers. In this connection it is reported that many mining and iron companies have schemes ready for the renewal of plant. The modern equipment of various works, especially those in Lorraine and Luxembourg, will compel these establishments which are still provided with old plant to bring it up to date, and electrical firms hope in this way to benefit by the provision of electric winding engines, pumps, rolling mill plants, &c. These schemes only need financing in order to be carried into effect, but this will first be possible when the banks, according to German custom, have disposed of the paper securities now in portfolio, and are able to deal with new securities.

Among various contracts which are reported to have been negotiated may be mentioned that credited to have been jointly obtained by the A.E.G. and the Schuckert Co. for the conversion of the horse tramways at Valparaiso to electric traction, the amount of the order being £300,000. The capital for the purpose of the alteration is estimated at £500,000, which is to be raised in Germany, Chili, and England. A second contract worthy of note is that which the Standard Construction Corporation, of London, is reported to have placed with the Bergmann Electricity Works Co., of Berlin, in connection with the construction of iron ore works at Dunderland, Norway. The establishment is to be lighted and operated by electricity, and the plant ordered for this purpose amounts to 12,500 H.P.

The Allgemeine Elektricitäts Gesellschaft, which has been remarkably successful in introducing the Nernst lamp, has now acquired the right of manufacture and sale of a new type of lamp which has been devised by M. Rignon, who is said to be an Italian. It was at first reported that the Rignon lamp is solely for the purpose of providing a cheap substitute for arc lamps for external illumination; but it is now claimed that the lamp will be equally suitable for internal lighting. This object is to be attained by reason of the small size of the lamp, and the great steadiness of the light, due to the special method of manufacturing the carbons.

The amalgamation of the Lahmeyer Co., of Frankfort-on-the-Maine, and the German Co. for Electrical Enterprises, of the same town, is now an accomplished fact as a result of the general meetings of the two undertakings which were held on February 17th. Suggested as far back as 1901, the fusion of the manufacturing company and its trust has been proceeding during the past year on the basis of two new shares of the Lahmeyer Co. being issued for three shares of the German Co., together with an interchange of obligations; and before the meetings took place the holders of 98 per cent. of the shares and 93 per cent. of the bonds of the latter company had already consented to the conversion. As the opera-

tion has now been completed, the whole of the property of the German Co. has passed into the possession of the Lahmeyer Co., which has realised a paper profit of £250,000 out of the transaction. This sum is to be placed to the reserve fund, the directors of the company not deeming it necessary to allocate it to the purpose of depreciation of works and plant. At the meeting of the shareholders in the Lahmeyer Co. it was stated on behalf of the directors that the works—apparently central stations, tramways, &c.—belonging to the German Co. were developing satisfactorily, and that the requisite means for the completion of undertakings in hand had been provided by a syndicate headed by the Darmstadt Bank. This credit, which is to be redeemed in due course by the issue of bonds appertaining to the undertakings to be completed, is based on the deposit with the banking syndicate of £375,000 in shares and bonds of the electricity works at Gersthofen. It has since transpired that the credit placed at the company's disposal amounts to £200 000, and is available until the end of 1905. In this connection it is noteworthy that the Darmstadt Bank, which thus finances the Lahmeyer Co., belongs to the banking group which was in close relation with the Union Electricity Co. and now with the Union A.E.G. group, and an indirect connection between the latter group and the Lahmeyer Co. is thereby established.

The German Co. for Electrical Enterprises, which, as previously mentioned, has been merged into the Lahmeyer Co., is now referred to for the last time in its individual capacity. For the year 1900-1901 the company was able to pay a dividend at the rate of 3 per cent ; in 1899-1900 6½ per cent.; and 7 per cent. in 1898-1899. The year 1901-1902 has, however, terminated with a loss of over £36,000, of which about £10,000 represents bankers' charges for interest and commission, £16,000 has been written off syndicate holdings, and £6,000 is due to losses on the discounting of bonds. After referring to the amalgamation with the Lahmeyer Co., the report stated that it would not be relevant to discuss the frequently raised question as to whether it is correct or faulty to establish so-called financial companies or trusts in connection with manufacturing companies. It pointed out that most other companies had done the same thing as the German company in one form or another —either the parent company acquired the shares of its financial trust or there was a complete severance of the two concerns. The report further suggested that the disillusions produced by financial enterprise companies had arisen from slow development—slower than had originally been expected—and from the comparatively high cost of installation, especially during the period of considerable prosperity which extended over the country a few years ago.

The firm of Körting Bros., of Hanover, which has a high reputation in regard to the construction of gas engines, is being converted into a company by the aid of the Berlin Handels Gesellschaft and the Allgemeine Elektricitäts Gesellschaft, of Berlin, the capital being fixed at £750,000. Among other matters, the scheme provides for the transfer of the electrical department of the Hanover firm to the A.E.G., which will be largely interested in the new company, and at the same time it proposes to develop the use of gas engines for electric lighting. It should be mentioned that in 1898 the firm established a working and finance concern, under the title of Körting's Electricity Works Co., for the purpose of acquiring, operating and financing electrical enterprises, and the firm undertook to guarantee the payment of dividends on the company's share capital until the end of 1905. This electrical company will continue to work its own undertakings under the guarantee of the partners in the Hanover firm, although the A.E.G. has the option of taking over the liability. It is assumed that when all the firm's electrical customers have been transferred to the A.E.G., the latter will discontinue the Hanover department as a manufacturing concern.

The directors of the Helios Co., of Cologne, have issued a circular announcing that the reorganisation of the company has now been carried through, and it is, therefore, again in a position to devote the whole of its attention to the requirements of customers. The communication adds that the directors are convinced they will fully succeed in meeting the wishes of clients owing to the completely modern and rational manufacturing equipments of the works. As far as the reconstruction of the company is concerned, it appears that by a considerable extinction of shares the capital has been reduced to £419,750 divided into 3,099 £100 preference shares, 1,546 £50 preference shares, and 651 ordinary shares of £50 each, whilst the additional payment which has been made on the first mentioned shares, has provided the company with cash exceeding £150,000.

The works of the Kummer Electricity Co., of Dresden, which collapsed a year or two ago, in consequence of speculative business and exaggerated extensions, are now proposed to be taken over by a new concern bearing the title of the Saxon Light and Power Installations Co. The new company is being formed by the co-operation of the first and second-class mortgage bondholders and the shareholders, the latter having to provide a large amount of fresh capital if they hope to see any return on the capital originally furnished by them. Negotiations on the subject of re-starting the works have extended over a considerable period, and in addition to the municipal authorities, the Saxon State Ministers have manifested deep interest in the scheme of reconstruction of the company, which at one time employed 1,500 workmen and officials.

The Oberspree Accumulator Works Co. has just issued its balance-sheet for 1902. It was founded by the Berlin Company for Electrical Enterprises, and in 1901 it was decided to dispose of the shares, amounting to £150,000, to the Berlin Accumulator Co. The Oberspree Co. terminated the year 1901 with a deficit of £33,592, and as its works have been idle during 1902, the deficiency has been increased to £48,236. The equipment of the factory has been transferred to the Oberschoneweide establishment of the new proprietary company.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON ELECTRONS.

By Sir Oliver Lodge, F.R.S., Vice-President.

(Paper read in London, November 27th, 1902.)

(Continued from page 372.)

APPENDICES TO PART IV.

APPENDIX F.

Size of Orbit of Radiating Electron.

Consider two electrons of opposite sign revolving round each other with luminous frequency n at any distance d; or better, consider a free negative electron revolving round a comparatively fixed equal positive charge attached to an atom, at distance d.

The force between them is $e^2/\kappa d^2$, so the acceleration is—

$$\frac{e^2}{\kappa a^2} \cdot \frac{3a}{2\mu e^2} = \frac{3av^2}{2d^2}.$$

But the acceleration is also expressible as $4\pi^2 n^2 d$. Therefore—

$$d^3 = \frac{3av^2}{8\pi^2 n^2} = \frac{3a\lambda^2}{8\pi^2} = \frac{3 \times 10^{-13}}{80}(6 \times 10^{-5})^2 = 10^{-23},$$

which is "Kepler's third law" for the case, and indicates that the distance at which luminous frequency is attainable is the atomic distance 10^{-8} centimetre; in other words, that the electron is roaming over the surface of the atom. If it got nearer to the centre of force than this, it would have to revolve quicker; and such rapid oscillations may be excited among the internal paired electrons by shocks and collisions, or other perturbation.

The most important aspect of the above calculation is that it corresponds with the hypothesis that the whole of the mass of an electron is electric, and none of it material or unexplained; for it shows that a pure electron is able to revolve at distances of the molecular order with luminous frequency.* The square of the wave length emitted is proportionate to the cube of the radius vector; provided the plane of the orbit contains the centre of force. Otherwise there may be constrained motion of smaller amplitude, analogous to that of a conical pendulum.

APPENDIX G.

The Radiating Power of a Steadily Revolving Electron.

Consider an electron revolving as above (Appendix F) in an orbit of atomic dimensions d with luminous frequency n; and calculate its radiating power.

The fundamental expression for the amount of energy emitted per second as waves in the ether, by a moving charge e, was given by Larmor in *Phil. Mag.*, December, 1897, page 512, also in "Ether and Matter," page 227, namely—

$$\frac{2\mu e^2}{3v}\dot{u}^2,$$

where $\dot{u}$ is acceleration, and where μe^2 may be taken as 10^{-40} gramme-centimetre, according to most recent measurements. But in a circular orbit of radius d the acceleration is—

$$\dot{u} = (2\pi n)^2 d = 40\,(5 \times 10^{14})^2\, 10^{-8} = 10^{23} \text{ c.g.s.};$$

therefore the radiating power of a single electron, so moving, is—

$$\frac{2\mu e^2}{3v} \cdot d^2 (2\pi n)^4 = \frac{2 \times 10^{-40}}{9 \times 10^{10}} \times 10^{46} = 2 \times 10^{-5} \text{ ergs per second.}$$

But the total available energy possessed by the revolving electron of linear dimensions a is only—

$$\frac{\mu e^2}{3a}u^2 = \frac{\mu e^2}{3a}(2\pi n d)^2,$$

namely, its kinetic energy (for of course it cannot radiate away or dissipate its electrostatic energy), and this amounts to

$$\frac{10^{-40}}{3 \times 10^{-13}}(2\pi \times 5 \times 10^{14} \times 10^{-8})^2 = 3 \times 10^{-18} \text{ ergs,}$$

its velocity being 3×10^7 centimetres per second, or one-thousandth that of light. So if the electron were isolated from any supply of energy, and if it could maintain the pace, it would at this rate radiate away all its kinetic energy in 10^{-8} of a second, that is to say, in three or four million revolutions. This may seem a rapid rate of cooling, but it is not surprising for an isolated atom at a red heat.

We may express the ratio of the radiating power of a single electron to its total luminous energy, by the fraction

$$\frac{2a}{v}\left(\frac{v}{u}\right)^2 = \frac{2a}{v}(2\pi n)^2 = 8\pi^2 n \frac{a}{\lambda} = 70 \text{ million per second.}$$

In any large assemblage of atoms, the radiation is not free and unrestrained, nor is it unmaintained, like this; but it must always be considerable at anything like luminous frequency, and it is proportional to the fourth power of the frequency. At a frequency which emits a wave ten times as long as a luminous wave the radiating power of a revolving electron is only one ten-thousanth of that above calculated, but even so it is significant; it must be

* See Lodge in the *Electrician* for March 12th, 1897, Vol. 38, p. 644.

remembered, however, that all substances are actually engaged in radiating energy, although at ordinary temperature there is usually absorption enough to compensate the loss.

The high speed of a revolving electron suggests, says Larmor, that it is apt to fly away tangentially with this sort of velocity when jogged off by any means; consequently he might attribute the high velocity of cathode ray particles to this cause rather than to propulsion by a gradient of potential. But it seems to me more likely that the orbital velocity is utilised only by those electrons which are flung off spontaneously from certain substances possessing one variety of radio-activity; whereas from charged surfaces, possessing a real propulsive force, electrons may be ejected so as to reach a speed higher than that, approximating more closely to the speed of light, a value which the rapid increase of inertia at such speeds would ensure that they should never actually attain.

APPENDIX H.

Faraday's Prophetic Nomenclature.

Students of the life of Faraday will remember that when he discovered the rotation of the plane of polarisation by a magnetic field applied to dense bodies in which light travelled along the lines of force—wresting the secret from nature by strong and pertinacious experimental research that would not be denied, though the time was as yet by no means ripe for comprehension of the fact when it was discovered—he labelled his discovery in a fit of enthusiasm, "The Magnetisation of Light and the Illumination of Magnetic Lines of Force," a label which puzzled contemporaries for a long time.

It is difficult to see what meaning he can have attached to these phrases; and for many years afterwards they appeared unsuitable misnomers, indicating a foggy conception of his own discovery.

It is not likely that his state of mind was really at all clear on the subject, and probably he would at a later stage have been willing to plead guilty to a less than lucid mode of conceiving the phenomenon; which nevertheless always specially pleased him, though when it was reduced to a mere rotation of the plane of polarisation, it seemed to many mathematicians and physicists to have lost its unique and surprising interest. It must always be remembered, however, that interest was never lost by either Lord Kelvin or Clerk Maxwell, and that it was the chief fact which incited Maxwell, many years later, to begin developing his electromagnetic theory of light.

But how do the titles strike us now? Do they not indicate some extraordinary unconscious insight, such as is frequently experienced by a great discoverer in the enthusiasm of discovery? Remember that the Hall effect, the Zeeman effect, the Aurora Borealis, and Faraday's rotation are all closely connected, by means of the electron theory.

In the cathode ray tube the flying electrons are deflected by a cross magnetic field; or if they fly along the lines they are twisted into a spiral path round them. In the Aurora Borealis this effect is carried out in the upper region of the air on a gigantic scale, and the earth's magnetic "lines of force are illuminated" by flying electrons from the sun entangled and guided by them. In the Hall effect this same influence is felt by the slowly moving crowd of electrons as they are handed on from one atom to the next, causing a curvature of the current path, in which either positive or negative may predominate. In the Zeeman effect the same cause operates on the revolving and vibrating electrons associated with a radiating atom and constituting a source of light; wherefore we may truly say that the "light is magnetised," for the source of light is magnetised directly, and the effect is impressed on and retained by the light emitted, and is made visible by spectrum analysis.

The first intimation of that magnetic influence on light which lies at the base of all these at first sight apparently diverse phenomena was detected by Faraday in his slight differential rotation of the plane of polarisation in one direction or the other by a magnet, according as the positive or the negative electrons in the dense substance were most affected.

Hence the title which he affixed to his discovery: "The illumination of the lines of magnetic force and the magnetisation of light," may be regarded as a prophetic flash of genius.

A not altogether dissimilar flash has already been referred to, when Crookes hinted prematurely that in the cathode rays we had something like corpuscular light, and also like matter in a fourth state, neither solid, liquid nor gaseous. For whether quite right or not, he was far righter than the critics of those days who presumed to deride him.

PART V.

Determination of the Mass of an Electron.

So far, all the measurements quoted have resulted in a consensus of certainty respecting our knowledge of e/m for gaseous conduction and radiation; and the measurements made on the cathode rays in a Crookes' tube, or near a plate leaking in ultra-violet light, have likewise given us a knowledge of their velocity, and shown that it is about one-thirtieth of the velocity of light, more or less according to circumstances. But so far no direct estimate has been made of either e or m separately. The difficulty of making these measurements is great, because we are dealing with an aggregate of an enormous and unknown number of these bodies. It would not be difficult to make a determination of the aggregate mass of a set of projectiles, say $N m$, where N is the number falling on the target in a given time, by means of the heat which the blow generates; or better, perhaps, by the momentum which they would impart to a moving arm after the fashion of a ballistic pendulum; provided their velocity u were known, as in this case it is. The aggregate energy, $\frac{1}{2} N m u^2$, or the aggregate momentum, $N m u$, could thus be found; but how is m to be separated from N?

Again, if the particles are collected in a hollow vessel attached to an electrometer of known capacity, it is not difficult to estimate the total quantity of electricity which enters the vessel in a given time, that is to say, to determine $N e$; but, again, how are we to discriminate e from N?

We may consider the following quantities experimentally determined, by researches carried on at the Cavendish Laboratory and elsewhere and so far already described or indicated:—

$$e/m$$
$$u$$
$$N e$$
$$N m$$

See above, Part III., for measurements of these quantities for the case of cathode rays *

Another thing that is comparatively easy to determine, especially in such cases as leak from a negative surface under the action of ultra-violet light, or the conductivity of air induced by the impact of Röntgen rays, is the total current transmitted; viz., the quantity $N e u$ the quantity of electricity conveyed per second. Measurements of this quantity have been made not only by Lenard † and Righi ‡ and Thomson, § but in various gases by Rutherford, ‖ now professor at Montreal; by Beattie ¶ and de Smolan at Glasgow, by Zeleny ** of Minnesota, by McClelland †† on hot gases from flames, and by McLennan, ‡‡ of Toronto.

Prof. Zeleny in particular measured the velocity by a safe and direct method of making the particles fly against a wind down a tube, and observing the rate of the current of air which was just able to withstand their progress: these measurements constituting a satisfactory confirmation of Thomson's and Rutherford's more indirectly inferred results.

If only it were now possible to *count* the corpuscles or electrons, to determine the number N which are started into existence, or which enter the hollow vessel, or which take part in conveying the current in the case of a leak by ultra-violet light, we should no longer have to *guess* at the actual value of e and of m separately, but should have really *determined* them

This brilliant research has actually been carried out by Prof. J. J. Thomson, by means of a method partly due to Mr. C. T. R. Wilson, supplementing a fact discovered by Mr. Aitken, and interpreted in the light of a hydrodynamic theorem arrived at long ago by Sir George Stokes.

I must be excused for waxing somewhat enthusiastic over this matter: it seems to me one of the most brilliant things that has recently been done in experimental physics. Indeed, I should not take much urging to cancel the "recently" from this sentence; save that it is never safe for a contemporary to usurp the function of a future historian of science, who can regard matters from a proper perspective.

The matter is rather long to explain from the beginning, and I must take it in sections.

(To be continued.)

* J. J. Thomson, *Phil. Mag.*, October, 1897.
† *Wied. Ann.*, Vol. 63, p. 253.
‡ *Rend. della R. Accad. dei Lincei*, May, 1896.
§ *Phil. Mag*, November, 1896.
‖ *Ibid.*, November, 1896, and April, 1897.
¶ *Ibid.*, June, 1897.
** *Ibid.*, July, 1898.
†† *Ibid.*, July, 1898.
‡‡ *Phil. Trans.*, Vol. 195, p. 49, 1899.

Manchester Section.

On Tuesday, March 3rd, the members of this Section of the I.E.E. discussed a paper by Messrs. E. W. Cowan and L. Andrews on "The Arrangement and Control of Long-distance Transmission Lines." The paper was illustrated by lantern views and experiments, and the authors are to be congratulated not only on the excellent manner in which they dealt with the subject, but also on the complete success of the experiments performed with the apparatus described in the paper.

Though it is not likely that very high pressures will ever be used for transmission work in this country, there is every reason for British engineers to study the problems connected therewith, and thus place our manufacturers in a position to compete for this work in various parts of the world. Of all existing systems of transmission, only one has been developed on the continuous current ("Thury") system, the remainder adopting alternating current. Of these, two, apart from the Deptford scheme, have adopted single-phase current, having an aggregate of 1,700 H.P. The two-phase system has been adopted in some 15 installations, with power, excluding Niagara, aggregating about 38,000 H.P.; whilst the three-phase system appears to have been used for 58 installations, aggregating over 200,000 H.P.

In a brief review of the systems of supply, the authors consider the three-phase alternating current system the most suitable at the present time to adopt for transmission work. The actual pressure that has been used appears to be a maximum of 80,000 volts, but the authors see no reason, given a liberal spacing of overhead wires, why 100,000 volts should not be used.

According to Mr. Parshall, 20,000 volts may be taken as the safe limit for underground cables, with higher pressures the cost of insulation and the capacity rendering their use prohibitive.

It is interesting to note that of the 73 power schemes referred to above, 30 operate at a frequency of 60 cycles or over, and 28 at between 50 and 60 cycles.

The authors advocated the earthing of the neutral point of the three-phase system, both on account of the saving in cost, and the greater safety.

The question of overhead and underground conductors was discussed, and for long distances underground cables were held to be inadmissible, not only on account of their cost, but also because their capacity with the high pressures necessary, results in an impracticably large condenser current. Poles for overhead construction are generally of wood from 35 ft. to 40 ft. in length, and they are spaced about 50 to the mile. In one case of a 60,000-volt installation, steel towers are used placed 440 ft. apart; it has been stated that the cost of this line does not exceed that of a first-class pole line.

The second part of the paper dealt with the control of the lines, and described appliances designed to overcome some of the difficulties of high-tension alternating-current working.

The first of these was a regulating transformer inserted in series with the feeders, by means of which the pressure on any feeder may be regulated as required by simply turning a hand-wheel fixed on the switchboard.

A similar booster is also arranged for cable charging. In the "Cowan-Still" cable charging system, the pressure may be gradually put on to the incoming feeder or cable from zero to a maximum, by this means.

The duplication of transmission lines is of the greatest importance, and interesting experiments were shown illustrating the disadvantages of ordinary duplicate systems, and a means to overcome these disadvantages.

Another interesting invention, the use of which was illustrated, is a "current direction indicator." This enables a faulty feeder or alternator circuit to be at once detected, thus facilitating the switching-out of a fault and the continuity of efficient supply.

Mr. Gunton opened the discussion. He thanked the authors for recording their invaluable work and congratulated them upon its success. He did not agree with the authors on the earthing of the neutral point of the three-phase system. A case recently came under his notice where a man had received a shock from one of the arms of a 6,000-volt system and had recovered from the shock. This system was not earthed; had it been so, undoubtedly the shock would have proved fatal, whereas he had only received a condenser discharge. The use of a motor alternator for charging the feeders, and discharging them, was found very satisfactory, and the operation could be quickly performed. There should always be duplicate mains (feeders), but in some cases it was not advisable that they should be run in parallel. Where, for instance, the mains fed a sub-station from which lighting and traction were supplied, it would be found advisable to use one feeder for lighting and one for traction, instead of running the two in parallel; should one break down, the other could, of course, be used for the whole supply. Double duplicate mains would be very costly.

Mr. Pooley thought the capital cost of some power companies could be reduced by having portable transforming apparatus. For instance, where the supply included seaside towns with a summer peak, and manufacturing towns with a winter peak, the apparatus could be used for the two cases. The cost of cables could be reduced if it were taken that the dielectric did not require to be proportionately thick with the higher voltages. He thought that the barbed wire run parallel to the transmission lines to overcome the effects of lightning, as described in the paper, would increase the capacity. The length of life of the line could be covered by a 5 per cent. depreciation fund, if the poles were well creosoted. The cost of aluminium wires worked out about the same as copper, but the poles could not be distanced to any appreciably greater extent with the former.

Mr. Clothier said that the authors had dealt with several important features of alternating current working, and that the flare switch for alternating current working was obsolete. The magnetic blow-out system in continuous-current working, owing to the tendency of the voltage to rise on the sudden breaking of the circuit, was bad. A question of vital importance was that of cable charging; there was much obscurity, and though there were numerous calculations and theories of what happened when a high potential was suddenly switched on or off a cable, there were few actual records of results. In America and in several British stations no "charging" appliances were used, and yet they had heard little of disastrous effects. Where they paying too much attention to the subject? He would like to know what were the limits before "cable charging" became advisable.

Mr. Nesbit was sorry that the first part of the paper consisted of an appreciation of overhead against underground cables. He thought what was often said of overhead wires must be taken with a grain of salt. A number of objections, more or less reasonable, were cited against overhead mains, and he concluded that overhead wires were a relic of barbarism. It was unfortunate that cable-makers did not know to what stress their cables would be subjected. In one instance, where the cables had to carry current at a pressure of 5,000 volts, it was found they were subjected to a pressure of from 12,000 to 13,000 volts every time they were switched on or off. Engineers should specify a maximum rise of voltage, and see that this was kept to; also, he would emphasise the importance of the alternator curve being as nearly a sine curve as possible. He agreed with the authors that it was advantageous to earth the neutral point of the three-phase system; by this means a saving of 15 per cent. could be made on the cost of the cables.

Mr. Coubrough noted with surprise that the authors thought the single-phase alternating current system could come into use again. The only chance for that system would be by the adoption of single-phase series motors, and then probably the two-phase system would be adopted. The only sound reason for adopting a two-phase system was the possibility of using the mains that had served for the single-phase system. Frequencies were steadying down to 50, and the lower limits were fixed by satisfactory lighting; probably 40 cycles would be found best for all round purposes. Generators varied very little in cost with frequencies, and the advantages of smaller capacity, charging current and lower impedance drop, were with the lower frequencies. Both arc and incandescent lighting were suitable at 40 cycles. More knowledge was wanted of the various alternating-current phenomena; he would suggest that a possible combination of an oscillograph and a cinematograph camera might be useful.

Mr. Kemp did not agree with the earthing of the neutral point of the three-phase system; this would necessitate more insulation on the generators, and would reduce the safety factor of the system. A case where a man touched one of the arms of the three-phase combination, and was not killed, was evidenced as proof of this. A method of charging cables by means of a step-up transformer and motor alternator, which had been in operation nine months, was very satisfactory. The Board of Trade required tests to be made at 1½ times the working pressure, and the "charging" plant had been most useful in this respect. The time taken to charge up a feeder was about 45 seconds.

Shortness of time prevented any further discussion, and Messrs. Cowan and Andrews replied very briefly to the points raised. From the statements made in the discussion, Mr. Cowan was prepared to modify his view on the earthing of the neutral point of the three-phase system. The increased capacity due to barbed wire for protection of transmission lines from lightning, was said to be inappreciable. The use of aluminium for overhead lines was a deep question, and would necessitate the consideration of strain and length of span. He thought the question of pressure rise in cables must be a matter for experiment; he was at a loss to understand why in some cases in America the frequency had been raised instead of lowered. Mr. Andrews thought that where a sub-station supplied current for both lighting and traction, duplicate mains for each should certainly be used.

A most hearty vote of thanks was accorded to Messrs Cowan and Andrews for their excellent paper. The paper which was to have been read by Messrs C. D. Taite and R. S. Downe on March 17th has been unavoidably postponed.

SOME NOTES ON CONTINENTAL POWER HOUSE EQUIPMENT.

By H. L. Riseley, M.I.M.E., A.M.I.E.E.

(Abstract of paper read before the Newcastle Local Section, February 16th, 1903)

On first entering a Continental power station, one is struck especially by the apparently extravagant amount of space which the switchboards and accessories occupy in the majority of central stations abroad. On closer inspection and consideration, one finds that this is not without an object; the object being primarily to provide for any contingency which may arise, and always to provide a duplicate method of operating in event of any part of the switching apparatus being deranged by accident.

A system nearly approaching the ideal was represented, in my opinion, by the central station at Paderno, 20 miles from Milan. There are seven turbine water-driven generators, having a capacity of 1,590 kw. each, speed of 180 rev. per minute, frequency 42 per second, 13,500 volts. The current is collected at the bus-bars, and thence led to the high-tension transmission line without the intervention of any transformers. At Milan the line ends at the Porta Volta station, where the pressure is transformed down to 3,600 volts, and at this station steam-driven generators are running in parallel with the transformed current generated at Paderno.

The apparatus for controlling the generators at Paderno is divided into nine panels, seven of which are for the seven generators, and the two panels in the centre serve for collecting the two sets of bus-bars and for placing wattmeters, &c. The whole of the installation from Paderno to Porta Volta had to be arranged so as to enable the two services to be separated at any moment into two distinct systems. For that reason the bus-bars are arranged in two groups, and each generator may be switched on either group; in that way the lines can be separated. Behind the generator panels are arranged in another room the high-tension transmission line boards. All the switchboards are extremely accessible. Each panel may be entirely separated from the live ones, so that it may be attended to and cleaned by the attendant in perfect safety. The panels are, as usual in Continental practice, made of marble and porcelain fixed on iron supports, no combustible material being used in their construction. The connections are all rigid bars, and the whole is a perfectly symmetrical, simple, and extremely mechanical job.

In my opinion the advantages of this type of board are its extreme accessibility and safety in having, so to speak, another way round, everything being in duplicate. Each portion of the apparatus can be made dead for cleaning or overhauling purposes without the slightest danger of interrupting the supply.

The first full-gauge electric railway was supplied from the Kander power house, equipped by Messrs. Brown, Boveri. At present about 3,600 H.P. are converted into electrical energy.

The five turbines are by Girard, of 900 H.P. each, at 300 revolutions per minute. The three-phase generators connected direct

to the turbines develop each 620 KW. at 4,000 volts. As the whole output of a machine has to be used at times on a single-phase lighting circuit, they are designed in such a manner as to enable them to develop their full power of 620 KW. at 4,000 volts as single-phase machines. Each of these generators is separately excited by a four-pole exciter of 12 KW. at 60 volts, the armature of which is mounted on the mainshaft. These exciters are in turn excited by two other direct-current machines, separately driven by turbines, each developing 14 KW. at 125 volts at 850 revolutions per minute. The reason for this is that the fluctuations in the speed of the main turbines have less influence on the pressure than if the field of the exciter were to decrease simultaneously with the speed of the generators and exciters. The field regulation of the generators can be effected either separately or in two groups or else all together, as desired. It is done entirely by means of the secondary exciting circuit. Any alteration of the resistance in the circuit of the secondary exciting machine is avoided by suitably arranged rheostats, which are switched on automatically during the regulation, so that in any case these secondary exciting machines always remain under constant load both during the regulation itself and after switching in and out of the fields of any number of generators.

The main switchboard is in another room. The bus-bars are divided into two sections, so that it is possible to operate two circuits, which are called steady and unsteady. The two sets of bus-bars are arranged in a circular fashion, so that either can be closed or open at certain points. In this way it is possible to work the two circuits either separately or together. The unsteady service supplies current to the Burgdorf-Thun line, the other supplying all the rest. Adjoining the generator panels at each end is a panel for connecting the two sets of bus-bars with transformers which transform the pressure from 4,000 volts up to 16,000 volts for transmission. Places in the immediate neighbourhood are supplied direct from the bus-bars at 4,000 volts.

In the transformer switch room are arranged in a clear and easily accessible manner all the switch levers and instruments for the primary and secondary circuits both for the transformers and transmission line. The high-tension fuses used on these consist of aluminium fuses in the usual Brown handle. All the switches and instruments of the 4,000-volt circuit as well as the 16,000-volt circuit are arranged, not on switchboards, but on light, open, steel structures, everything being well supported on insulators.

Three lines are utilised in working the Burgdorf-Thun line. Three go to Burgdorf; five to Berne, two single-phase and three three-phase.

The distribution in Berne takes place from a closed-ring circuit formed by the five wires, and surrounds the whole town, to which circuits are tapped on four transformer stations. There are four transformers in each station, although the buildings are designed to take seven, each having a capacity of 50 KW. The switches, fuses, ammeters, and lightning arresters are arranged on identically the same lines as at the central station. The ring circuit can be disconnected from the transformers by means of two special switches operated by long levers outside the building, so that the portion of the ring circuit situated between two sub-stations may be deprived of the current without entering the transformer stations. The pressure is reduced by transformers to 3,000 volts, and the current passes from the secondary bus-bars to the underground cables supplying the town. Inside the town the pressure is reduced to 250 volts for driving motors, and to 125 volts for single-phase lighting.

The operation of this installation presents special difficulties, on account of its being necessary not only to supply a large amount of current for lighting and power purposes only, but also at the same to provide for extremely large variations in the power required for the railway traffic. It is by no means exceptional for the railway to suddenly take as much as 1,200 H.P. To sum up, the special points to my mind worthy of attention are that the various duplicate bus-bars are all arranged as ring circuits, which can be divided into any desired section, so that all kinds of combinations in working can be readily effected. The transformers used are all single-phase, which allow in case of any of them getting out of order, to switch in at once a reserve transformer into the corresponding phase. The output of one phase can be increased by switching in further transformers, which, as in this case, where the whole lighting circuit is connected to one phase, is of special importance for the regularity of the supply.

A short account of the Lecco-Colico Railway may be of interest. As is well known, the system is three-phase, with the overhead line at a potential of 3,000 volts. The power is primarily generated at Morbegno at a pressure of 18,000 to 20,000 volts direct. The plant consists of three 2,000-H.P. generators running at 150 revolutions per minute, 15 cycles, having a capacity of 1,300 KW.; exciters on turbine shaft end.

There are practically two sets of main high-tension bus-bars, and each generator feeds into both through high-tension circuit breakers. The current is conveyed from the power house to nine sub-stations situated at the side of the track; at these sub-stations the pressure is reduced to 3,000 volts, which is carried on the overhead line. With one exception the sub-stations each contain one three-phase transformer of 300 KW. normal rating, but capable of working for a short time up to 900 KW. The transformer sub-stations are separate stone buildings alongside the railway stations.

The transmission line, at 18,000 volts, runs parallel to the railway, but, of course, does not run through the tunnels, of which there are a great number, but over the mountains; nor does it run through the stations. Lightning arresters are placed on the primary line at every three miles, and on the secondary every 1½ miles. A separate span wire is always used for each phase, double insulated, and the rails are used as a return. All the rails are bonded with ordinary trolley wire, only instead of the pin being solid it is hollow, and collapses when being driven in; in no case has trouble been experienced through defective contact. The track is also cross-bonded at about every 300 yards.

On making a trip on the track I found that the acceleration was extremely even, there being no jolting whatever. The starting resistances on the car consist of water in a tank with fixed plates, the level of the water being raised or lowered by compressed air, which is also used for the Westinghouse brake, the whole apparatus being worked by a small valve in the driver's compartment. The air compressor is driven by a small motor with an automatic switch, which stops the motor when there is sufficient pressure in the tanks. The trains take up to 90 amperes at 3,000 volts to start up, this being the maximum, and from experiments a train on a gradient of 17 in 1,000, with a draw-bar pull of 4 tons, got up to speed in 37 seconds. There are loop lines on the overhead line through the stations, which are made dead as soon as the train comes to a standstill; also the trolley boom is lowered, this being operated by compressed air, and in the event of a car standing for a long time, there is a small hand-pump to get sufficient air pressure to raise the trolley.

There are two ways of lighting the trains, either with accumulators or else by means of transformers and lamps with three filaments at 100 volts 15 cycles. A small 8-KW. transformer supplies current for the lamps, motor, compressor and heating. The flickering of the lamps was hardly perceptible, more especially those behind ground glass. The same system of lighting was employed at the stations. The main switch on the car was operated by compressed air, and there was an interlocking arrangement, by means of which it was impossible to get at the switch if the trolley was up, and impossible to put the trolley up if the switch was open. The trolley was of novel construction, consisting of a copper pipe running on roller bearings, and the whole supported on a wooden shaft. These trolleys have run 30,000 miles without being renewed. The cars are mounted on two four-wheeled bogies, each of which has one primary and one secondary motor mounted direct on the axles. They weigh about 50 tons, and can seat 56 passengers.

The loco. gives a draw-bar pull of 10,000 lbs. at 19 miles per hour. The body of the loco. is mounted on two four-wheel trucks. Upon each of the four axles a motor is directly mounted, no gearing being used. All these motors are primary, and speed regulation is obtained by using either one, two, three or all motors to suit the conditions. The rotor shaft, which is hollow, is connected to the car axle by a flexible coupling. The average rate of speed is fairly high, as the acceleration is very rapid, although the maximum speed is not excessive, it only being 60 km. per hour. They were able to coast above synchronous speed down hill. The two most efficient speeds were 30 km. and 60 km. per hour. The whole scheme, including power house, water power and canals works out at £4,500 per mile.

On carefully considering the design of the foregoing power-houses and equipment, it seems to me that two things have especially been aimed at—viz., simplicity of design, and a duplicate arrangement of all gear as far as possible. In getting out designs for new power-houses engineers generally consider that the most economical load for the engine shall be that of the maximum load of the generator, and also that, by lengthening the cut-off on the engine, the generators shall be capable of being greatly overloaded without reducing the speed of the engine. In the new power schemes that are before us to-day, it is necessary to take all precautions possible to keep the station bus-bars alive at all times and at all costs, notwithstanding any local disturbance which may be taking place outside the control of the power-house; fuses do not always clear themselves, and they thus blow the generator fuses, causing endless trouble. By making all the steam plant identical and of sufficiently small capacity, so that in case of a heavy overload it will slow down, all fuses and automatic circuit-breaking devices on the generator panels may be avoided. In the event of a short occurring on a long-distance high-voltage transmission line, the fault would almost immediately clear itself. In case of a continued short-circuit, the lower voltage limits the power which can flow through a fault. By this system any interruption to supply would probably be of very much shorter duration than if fuses are to be replaced and the automatic circuit-breakers closed, after a general opening of all these devices.

A QUESTION IN BALANCING.

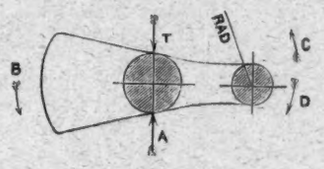
By W. H. BOOTH.

In a recent paper on engine balancing read by Mr. Rounthwaite before the Institute of Marine Engineers, the author made the following very curious statement, when discussing the inertia of the moving parts of an engine.

"Similarly, in a vertical steam engine, at the commencement of the down stroke, say, although there is the same pressure on the piston as on the cylinder cover, part of that applied to the piston at the commencement of the stroke is absorbed in setting the piston in motion, *and never reaches the crank pin or main bearing*, so that, for the time, the pressure on the cover exceeds that on the main bearing brass, and there is a tendency to lift the whole engine; towards the end of the stroke the pressures are reversed, the piston giving out energy, and so causing a pressure on the main bearing which is in excess of that on the cover, and so on."

This sentence points out an error in thought which prevails amongst almost all who have gone into the question of engine balancing.

We hear so much of the question of the inertia of the moving parts, and absolutely nothing of the inertia of the heavy engine itself. The moving parts are those which are not rigidly attached in every direction to the engine as a whole, and consist of the piston and its rod and crosshead, and of the connecting rod and crank. The crank can be absolutely balanced in every direction by the attachment of a tail. The other moving parts can only be balanced in one plane by means of revolving weights, but may be balanced by bob weights in their own plane of movement without introducing unbalanced forces in a transverse plane, as when revolving balances are employed. Owing to the inertia of the piston, the steam stress is not all transferred to the main bearing. This may be perfectly true, and there may be a tendency to lift the whole engine, because the steam on the cylinder cover has an abutment, the piston mass hanging in space, against which to exert its pressure. But the mass of the cover and the parts rigidly attached to it is very great. The attached parts include the cylinder, framing, bedplate, bearings, main shaft, and



cranks—even if revolving, and be it noted, the connecting rod and piston also, for the main bearings cannot rise vertically without exerting a tendency to stop the downward movement of the piston, as a study of the annexed diagram will make obvious. The main bearing exerts an upward thrust, represented by the arrow A. The fantail of the crank, moving though it may be, and the crank itself, will not change their rate of movement unresistingly. An upward thrust A produces equivalent resistances B and C contrary to the direction of rotation D, and the piston is correspondingly checked.

The sentence quoted from the paper ignores the inertia of the engine and the component inertia of the moving parts which are brought into effect as just shown. Probably if some mathematical genius would investigate the subject properly he would find that the inertia of the moving parts could not justifiably be treated as introducing the effect which the author of the paper seems to indicate. The lifting of the whole engine seems to be a myth which has arisen from too narrow views of the inertia of the moving parts. Is not the cylinder a moving part relatively to the piston? Does it not seem correct to claim that the combined effect of the inertia of the heavy engine and the reflex inertia pointed out of the "moving parts" will neutralise the effect hinted at by the author?

The error into which it is here claimed all balance theorists have fallen is the neglect of the upward thrust A of the bottom main brass. They recognise only a downward thrust T exerted by the shaft on the bearing, forgetting that the effect of a thrust A is felt in the piston rod—all the more quickly too when the crank has a heavy tail.

Obviously, if my argument be true, the importance of non-slackness of the main bearings is enhanced. Unless the crankshaft was down on its bottom brass the reflex action I have pointed out could not come into play until the engine had risen by the amount of the slackness and, with the engine, of course, the ship attached to the underside of the bottom brass.

On the other end of the stroke the converse holds good, and slackness of the top brass permits the ship to be dragged deeper into the water—an infinitesimal amount it may be, but one that is calculable—and that probably causes more vibration than the opposite effect, the lower brass being rarely out of contact with the shaft.

The conclusion drawn from the above considerations is that an engine with tight bearings is self-contained, both mechanically and dynamically, and therefore should be capable of a perfect balance by means of bob weights.

Nor does it seem probable that the contrary can be demonstrated mathematically, for we know by actual practice that a high-speed engine can be run with silence if care be taken not to introduce rocking couples.

CARBON RESISTANCES.

The use of thin films of carbon as high resistances has long been known. They are easily made, and, therefore, cheap; whereas the cost of wire resistances of several megohms would be very great. One of the commonest forms of carbon resistance is a graphite line drawn on a ground-glass surface.

Carbon resistances have, however, several serious defects. In the first place, their resistance increases with time, rapidly at first, and then more slowly. In the second place, it has hitherto been found very difficult to make good contact between the film and its terminals. A joint made by casting on lead, or even by depositing copper electrolytically, contributes a considerable percentage of the total resistance, and owing to unequal expansion it varies greatly with changes of temperature.

Mr. A. C. Longden describes in the *Physical Review*, Vol. 15, p. 360, a method of making the junctions between the terminals and the carbon film, which appears to be an immense improvement on previous methods. His carbon film consists of a film of smoke deposited on a strip of glass. It makes very little difference what kind of smoke, but camphor smoke is recommended as being a little more uniform than candle smoke, or smoke from a gas flame. A film 5 cm. long by 1·5 cm. wide may have any resistance from about 50,000 ohms to about 100 megohms, according to the thickness of the deposit. It was found to be possible to deposit copper electrolytically on the ends of the smoke films, but the resistance almost invariably increased enormously afterwards, in many cases rising to infinity. A microscopic examination revealed the fact that the connections between the films and the terminals had been weakened or severed by minute cracks in the films, just at the edge of the copper deposit. Mr. Longden then resorted to a method which he had previously used with success in dealing with platinum films. It consisted in first coating the ends of the strip of glass with metallic silver, chemically deposited by dipping the end of the glass strip in a solution of a suitable salt of silver. The film of smoke is then deposited in a uniform layer over the entire surface of the glass and silver. The silver tips may be thick enough to stand electrolytic depositions of copper at the extreme ends, or they may even be made so thick that fine copper wires may be soldered directly to the silver.

Tinfoil terminals attached to the glass with shellac and thoroughly baked were tried, but the smoke films which were afterwards deposited were always thinner at the edge of the tinfoil than elsewhere, and in the case of very thin films there was lack of continuity at this point. The silver film has the advantage that it is thinned out to a fine edge during deposition, owing to the fact that capillary attraction draws up a thin layer of the solution on to the surface of the glass. For this reason the silver film, however thick, always terminates in an indefinitely thin edge, so that the layer of smoke which is afterwards deposited is perfectly continuous and uniform over the entire surface of glass and silver.

Figs 1 and 2 show a tinfoil and a silver film junction in

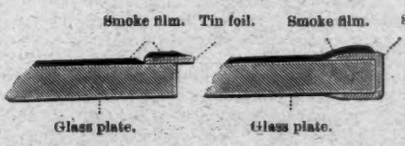


Fig. 1.

Fig. 2.

cross-section. It may be seen that the smoke film is broken by the abrupt descent at the end of the tinfoil strip, while the film ascends without a break over the sloping edge of the silver tip. Careful tests have shown that the resistance of these silver junctions is negligible, compared with the total resistance of the carbon film.

To preserve these delicate films from injury during handling and use, it is sufficient to harden them in a bath of alcohol vapour, and then to flow over their surface a coating of shellac varnish, india-rubber dissolved in bisulphide of carbon, or melted paraffin. If shellac varnish is used as a protecting material, the varnished film should be pretty thoroughly baked at about 110° C. in order to remove all the alcohol and water from the varnish. If perfect protection is required the film should be enclosed in a dry wood or hard rubber case and provided with binding posts.

These silver-tipped carbon smoke films increase in resistance with time, but they reach a comparatively constant state much sooner than other forms of carbon resistances. With voltages varying from 4 to 140 volts, the resistances do not change more than a few tenths of 1 per cent.

Exhibition.—An international exhibition will be held at Limoges from May to September this year. Mechanical, electrical and civil engineering works will be represented.

AUTOMATIC REGULATION OF VOLTAGE IN CENTRAL STATIONS.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

A new type of quick-acting automatic voltage regulator has been developed by A. A. Tyrell, and is being placed on the market by the G.E. Co., of America. It can be applied to either continuous or alternating current circuits, and may be used for keeping the voltage of the generators constant, or for automatically regulating feeder pressures. A novel feature of the regulator is, that the control is effected by opening and closing a short circuit on the field rheostat, thus cutting in and out resistance in the field circuit of the generator, the voltage being varied by the length of time the resistance is included in circuit and out of circuit. This operation is made at a high rate of speed, varying from 50 to 800 times a minute, and the movement of the contacts which switch the resistance in and out is accomplished by a relay, the motion of the contacts being about $\frac{1}{16}$th of an inch.

The voltage of an alternating current generator is controlled by varying the resistance in the field of the exciter in accordance with the diagram of connections shown below (taken from the *Western Electrician* for January 31st, 1903). It is claimed for the apparatus that when once adjusted it will maintain constant potential. Without any further attention, and quite irrespective of the character of the load and speed, the alternating current and direct current control magnets together operate a pair of floating contacts

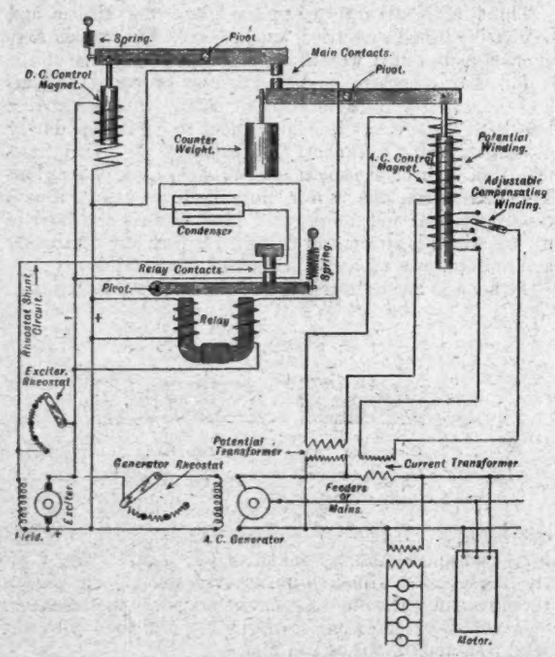


Diagram of Connections.

which in turn operate the relay magnet, and the latter opens or closes the shunt circuit across the exciter field rheostat. The apparatus applies so much energy in changing the voltage that it overcomes at once any reluctance of the field. For that reason the exciter has to be one with a wide range of voltage, say, 125 volts down to 40 volts to get a 110-volt working result. To reduce the voltage of the alternator slightly, the apparatus is first varied considerably and then brought back to the position required; just as with a hand regulated rheostat for quick regulation, the arm of the rheostat is momentarily thrown clear round and then brought back to the point at which it is to remain.

The supply of current to customers at constant pressure is a very important matter, because an increase of only 1 per cent. has a marked effect, and may reduce the life of a lamp by some 18 per cent., whilst only increasing its candle-power by 6 per cent.

Another point in connection with this matter is that high-efficiency lamps, taking 3·1 watts per candle-power, can only be used when the voltage is maintained constant. Where there is pressure variation, lamps taking 3·6 watts or more have to be used, and this means that for any given station the lamp connection may be reduced as much as 14 per cent. If, therefore, by the addition of an automatic regulator or other means, any improvement is made in the supply voltage, the additional expense and complication of such apparatus may be justifiable.

It is somewhat interesting to note that although the voltage drop of continuous current central station generators is about double what it is with alternators working on a lamp load, and further, although there is a much greater drop in the low tension feeders, yet as a rule it will be found that continuous current is supplied at a much steadier pressure than alternating current. It would, therefore, appear that the very fact of there being high losses in continuous current plant has indirectly proved of considerable advantage by *necessitating* the use of feeder regulators and pilot wires, &c.

Of course, compound winding of dynamos has helped somewhat in isolated plants and for traction work, but for lighting work from central stations all dynamos are shunt wound, and in this respect they are no better or worse than the ordinary alternator. It should be noted that even if some really satisfactory and cheap method of compounding alternators was introduced, there would still remain the fact that compounding does not correct for alteration in speed of prime mover or for temperature changes.

The writer must confess to having a horror of jim-jam switches and other similar apparatus, and the diagram shown herewith does not impress one, yet at the same time anything which draws attention to the poor pressure regulation of central station supply is so much evidence to the good. The extensive and growing use of curve-drawing or recording instruments is disclosing how very variable is the pressure given by many central stations, and if customers begin to use these instruments to any extent there is likely to be trouble in store for managers of such stations.

It is beginning to be recognised that price per unit and discounts are not the only considerations for the customer to study. He is, in fact, much better off when paying a little more per unit if, by doing so, he is enabled to use lamps taking only 3·1 watts per candle-power.

MUNICIPAL CORPORATIONS (REPRODUCTIVE UNDERTAKINGS).

The practical usefulness of Sir Henry Fowler's Parliamentary return is considerably impaired by its being limited to the undertakings of Corporations in England and Wales, and by its excluding the metropolis. A large number of Urban District Councils are working provisional orders for electric lighting which are not included in the return, and these, with the Metropolitan Boroughs, Scotland and Ireland, would materially affect the general result.

In the summary showing the totals for the trading in electricity supply during the four years from March, 1898, to March, 1902, the average annual net loss is stated as £11,707. But if the undertakings which are excluded from the return were taken into account, the amount of the loss incurred would be found to be so much larger as to render the present return of little value in dealing with the actual outcome of the trading.

As we pointed out in our article of the 27th ult., the loss stated almost leaves the question of provision for antiquation and depreciation of plant untouched. A few of the local authorities accept the sound principle of accountancy involved in this matter, but the total amount set aside for the purpose is only £19,970 upon a capital expenditure of £12,508,997; it is noteworthy, however, that the towns which have adopted the right course include Exeter (which sets aside all the surplus for this purpose, after providing for the sinking fund); Bristol (a small amount, not made upon any fixed basis); Stafford (1 per cent. on capital outlay); Nottingham (no fixed basis); Bolton (not ½ per cent.); Kingston-upon-Hull (renewals met out of revenue, 10 per cent. written off meters annually); Bradford (depreciation based upon engineer's estimate of duration of various por-

tions of the plant); Halifax (no fixed basis); Huddersfield (available surplus set apart for depreciation and contingencies); Leeds (no fixed basis); and Sunderland (no fixed basis).

The return does not include Scotland, otherwise it would have shown that Glasgow, Aberdeen, and other important places fully recognise the necessity of providing for depreciation, and what the return calls "*obsolescence*," or the process of becoming obsolete.

In the case of West Ham, the sum of £1,000 was set aside last year as a reserve, which may be necessitated by "obsolescence, disaster, or other extraordinary causes," a very modest provision, but indicating a desire to tread in the right path.

The exclusion of the metropolitan area is very serious, the undertakings being upon an extensive scale, and including Hackney (which, as we have shown, was at least £13,000 to the bad at the end of 11 months' trading), Islington (which claims a surplus of £1,402 upon the sixth year of working, on a capital expenditure of £365,843, without providing for depreciation, and making a large profit upon the public lighting, about 3d. per unit being charged, against total costs of 2·48d.); Hampstead (£1,659 paid out of rates towards deficiency); Hammersmith; St. Pancras; Shoreditch; Southwark; Stepney (including Whitechapel); Battersea; Fulham; Bermondsey; and Poplar—not one of which can be proved to have made a profit upon its electric undertaking if "obsolescence and depreciation" are provided for. The capital outlay upon these metropolitan schemes exceeds two millions and a quarter.

The undertakings of the Urban District Councils which are omitted from the return, also aggregate a very large expenditure, and their average losses during the period covered by the return would swell the total enormously; thus it is clear that a more complete return, made annually, is absolutely necessary before the facts are ascertained upon which the public can judge of the financial results of the speculations in electricity supply. These towns include such places as East Ham, Buxton, Fareham, Leyton, Barking, Barnes, Beckenham, Ilford, Morecambe, Rathmines, Redditch, &c., where deficiencies are admitted, apart altogether from the question of provision for depreciation. By omitting the municipal electric undertakings of Ireland, the deficit of Dublin does not add its loss to the total; in this case, £3,568 represents the loss upon the ninth year of trading, and there is also Belfast, with its bad record at the end of the seventh year.

If the example of the Brompton and Kensington Electricity Supply Co. were followed in making up municipal electric accounts, the eyes of the ratepayers would be opened very widely to the dangers attending amateur interference with a technical business, which should only be undertaken by experts and with private capital. The company we refer to sets aside £14,000, equal to 6·35 per cent. on its capital expenditure, half of which goes to a depreciation fund, and the remainder to extinguishing the cost of patents. The Westminster Electric Supply Corporation, Ltd., also provides for depreciation by reserving for the purpose 3·40 per cent. upon the capital expenditure.

The Chelsea Electric Supply Co. devotes £8,960—to depreciation and renewals—based upon the estimated life of the different descriptions of plant and property.

The Kensington and Knightsbridge Electric Lighting Co. has a renewal account of £44,144 16s. 1d.; the London Electric Supply Co., a reserve of £6,000, and the City of London, £35,000.

This is sound accountancy, and if all the accounts comprised in the Parliamentary return under consideration were prepared upon a similar system, instead of the small sum of £19,970 which appears in column 16, the amount would have been more like £400,000!—and the loss upon the municipal trading increased accordingly.

The re-appointment of the Joint Committee of the Houses of Lords and Commons to inquire further into the position of this matter is of essential importance to the public, and it is also necessary to deal with the removal of the obstructions to the electric supply industry by amendments of the Acts which govern it, and the powers vested in the Board of Trade and Local Government Board with reference to the grant of Provisional Orders and sanction of loans.

A Government audit of municipal accounts is also a pressing necessity, in order to secure some uniformity in the system as to provision for the contingencies referred to, for example in the return in relation to West Ham, and also to deal with such points as the rating of the undertaking, charge for clerical services of the town clerk's and surveyor's staffs, profit on public lighting, &c.

In numerous cases the charge for public lighting is in excess of the cost, the profit going to swell the revenue of the electric lighting account at the cost of another department—robbing Peter to pay Paul. In a recent instance, the whole of the adverse balance on the electric undertaking has been added to the public lighting account, such a system being a convenient method of concealing a loss, although in effect it is the same as if the amount had been directly paid out of the rates.

The *Municipal Journal* makes a lame attempt to explain away our comment upon its statement that the result of the municipal trading according to the Parliamentary return, was an amount of £656,376, which "no doubt went in relief of rates." It admits that the surplus *net* profit was only £378,281 upon the trading; we repeat, therefore, that we fairly represented the comments of our contemporary, which struggles to get out of its misrepresentation by eliminating losses on the plea that they occurred on undertakings which should not be self-supporting, and are, therefore, according to its views, improperly included in the return as "reproductive undertakings." This is a point it must settle with the authors of the return; we can only take it as we find it and deal with the figures as presented.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Pros use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"M." writes:—"I obtained a contract to supply and fit up dynamo, accumulators, and wiring, in a certain job, the dynamo to be driven from an existing turbine and water supply, our work ending when we had fixed a pulley on an existing countershaft, and put on a belt from that to dynamo. When we started charging we found that the water supply only lasted from six to eight hours, and then the dam required 36 hours to fill again. In these circumstances our charging period, instead of ending in about 36 hours, extended over several weeks.

"The consulting engineer disallows our account in view of the fact that we made no protestation *before* charging.

"We had been informed, however, by the proprietor's representative that the water supply would more than meet our demands; and on finding out after the first six hours' charge the insufficiency of the water supply, we then informed the consulting engineer.

"Are we justified in sending in an account to the proprietor for the extra expense involved?"

*** The question in this case appears to depend in the first place upon whether it was a term of the contract to put up the installation that the contractor should charge the accumulators. If he was bound by a written agreement to do this, it would seem that he cannot now be heard to say that there was not sufficient water, as in that case he must be taken to have contemplated the exact length of time, and the amount of water which he would require. If, however, his duty to charge the accumulators is merely implied; or if an agreement to do so was entered into by him on the faith of the verbal representation that there was sufficient water to effect the charge in 36 hours (that being the usual time necessary) it is conceived that he can claim extra for additional work and labour done.

Services, however long continued, create no claim for remuneration without a bargain for them, express or implied, from circumstances showing an understanding on both sides that there should be payment (Reeve *v.* Reeve, 1 F. and F., 280).

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 323, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

4,208. "Improvements in and relating to the cells of primary and secondary electric batteries." W. E. Heys. (The Hutchison Acoustic Co., U.S.) February 22rd. (Complete.)

4,234. "A hydro-electric single liquid pile, which is automatically renewed." H. Piquer. February 23rd. (Complete.)

4,244. "Improvements in regulating or controlling currents of gas or electricity." H. V. Gill. February 23rd.

4,270. "Improvements in commutators of dynamo-electric machines and motors." E. W. Drake. February 24th.

4,275. "Improvements in electric regulating switches." H. W. W. Dix. February 24th.

4,311. "Improvements in insulators." W. Brandes. February 24th. (Complete.)

4,323. "Improvements in telephone selecting devices." W. D. Watkins. February 24th. (Complete.)

4,346. "Improvements in insulated electric conductors and in methods of manufacturing the same." E. A. Carolan. (The General Electric Co., U.S.A.) February 24th.

4,368. "Improvements in electrodes for reversible galvanic batteries." H. Cottrell. February 24th. (Complete.)

4,369. "Improvements in frames for battery electrodes." H. Cottrell. February 24th. (Complete.)

4,398. "Improvements in electrical resistances." R. W. Paul. February 25th.

4,389. "A new system of contact breaker for the primary circuit of induction coils." R. Chauvin and B. Arnoux. February 25th. (Complete.)

4,390. "A chain and pulley combination appliance utilised for raising and lowering weights at the extremity or other part of a curve and projecting electrical conductors or other material from the moving rope." J. Stevenson, jun. February 25th.

4,393. "Improvements in and relating to electrical appliances for the prevention of the racing of marine engines, and in the construction of solenoids therefor also applicable to other purposes." J. MacLean. February 25th.

4,410. "Method of producing storage battery plates." W. Fairweather. (The General Storage Battery Co., U.S.) February 25th. (Complete.)

4,413. "A method and device for collecting and putting to practical use the electricity from the interplanetary ether." A. G. Whitney. February 25th. (Complete.)

4,442. "Device for effecting a connection of electrical conductors between the rails of electric railways." C. Bauer. (The Helios Elektricitäts Aktiengesellschaft, Germany.) February 25th.

4,444. "Improvements relating to dynamo-meters." E. Weston and A. O. Berecke. February 25th. (Complete.)

4,459. "Improvements in electrical generators adapted to give currents of approximately constant potential when working at varying speeds." H. Wauchope. February 25th.

4,500. "Electro-magnetic improvement to marine governor." J. M. Reid. February 26th.

4,519. "Improvements in electric generators and motors." J. C. Stewart. February 26th.

4,520. "An electric current alarm for use in effecting combinations in electric generators, transformers and batteries and like purposes." A. R. Hakoumoff. February 26th.

4,533. "A new or improved method of regulating the voltage of alternating and continuous current generators by means of alternate current excitation." Crompton & Co., Ltd., and R. Goldschmidt. February 26th.

4,557. "Improvements in or connected with electric arc lamps." F. M. Lewis. February 25th.

4,560. "Improved means for operating electric time indicators." G. B. Powell. February 26th.

4,585. "Improved means and apparatus of adapting telephones to electric bell systems." J. Young. February 27th.

4,618. Improvements in apparatus for electrically igniting mineral safety lamps." W. Best. February 27th.

4,675. "Improvements in apparatus or forms for use in the construction of conduits and pockets of boxes specially applicable as containers for the underground conductors of electric traction systems." J. G. White & Co., Ltd., and I. H. Fisher. February 27th.

4,681. "Improvements in or connected with electric cables and the jointing of the same." A. P. Hanson. February 27th.

4,682. "Improvements in or connected with telephonic exchange apparatus." A. P. Hanson. February 27th.

4,698. "Improvements in electrical measuring instruments." J. Ferguson and Kelvin & James White, Ltd. February 28th.

4,699. "A new or improved construction of portable electric hammer," J. Sampson and H. B. Stocks. February 28th.

4,703. "Improvements in and appertaining to holders for electric incandescent lamps." C. H. Jones. February 28th.

4,704. "Improvements in telephone receivers." W. G. Hevs. (The Hutchison Acoustic Co., U.S.) February 28th. (Complete.)

4,709. "Electrically-driven vertical saw frames for cutting wood." J. Barr, of the firm of John McDowall & Sons, and R. Anderson. February 28th. (Complete.)

4,710. "Apparatus for controlling the raising and lowering of weights by electric power." H. Shoosmith. February 28th.

4,727. "Improvements in or relating to resistance regulators and starting switches for shunt motors." Mechwart Coltri & Co. February 28th. (Date applied for under Patents Act, 1901, August 29th, 1902, being date of application in Italy.) (Complete.)

4,732. "Improvements in reversing mechanism for dynamo-electric machinery." H. Leitner and R. N. Lucas. February 28th.

4,735. "Improvements in and connected with safety fuses." W. Norbes. February 28th. (Complete.)

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

20,985. "Improvements in and pertaining to ordnance." W. L. Wise. (K. Birkeland.) Dated October 18th, 1901.

21,021. "Improvements in and connected with the supporting standard and trolley arm used in overhead electric traction schemes." R. L. Ross. Dated October 21st, 1901.

21,056. "Improvements in or relating to electric arc lamps." Jandus Arc Lamp and Electric Co. and A. D. Jones. Dated October 21st, 1901.

21,084. "Improvements in and relating to feeders for street tramcars." G. Massey. Dated October 21st, 1901.

21,086. "Improvements in and relating to telegraphic receiving instruments." J. F. Skirrow. Dated October 21st, 1901.

21,090. "Improvements in balloons or apparatus for aerial navigation." A. Severo. Dated October 21st, 1901.

21,123. "Improvements in or relating to massage apparatus or rollers." A. B. Boyer. Dated October 22nd, 1901.

21,170. "Improvements in electric cables." M. J. P. G'Gorman. Dated October 22nd, 1901.

21,205. "Improvements in or connected with electricity meters." G. J. Lorrain. (H. A. Macdonald, Paris.) Dated October 22nd, 1901.

21,263. "Improvements in electric time switches." C. H. Offord and S. Jevons. Dated October 23rd, 1901.

21,292. "Improvements in electric heaters." C. Danilevsky. Dated October 23rd, 1901.

21,293. "Improvements in electrically-illuminated signs." J. H. Goehst. Dated October 23rd, 1901.

21,294. "Improvements in electric accumulator batteries." A. Trebelhorn. Dated October 23rd, 1901.

21,328. "A waterproof cone, cap, or cover for protecting the holders of electric glow lamps," S. Miller. Dated October 14th, 1901.

21,337. "Protective appliance for electrical conductors." O. F. Parment. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, March 27th.) Dated October 24th, 1901.

21,353. "Improvements in or relating to means for operating railway switches, signals and the like." A. J. Boult. (A. Neelemans.) Dated October 24th, 1901.

21,363. "Improvements in secondary batteries." C. T. J. Oppermann. Dated October 24th, 1901.

21,387. "Improvements in electrical apparatus for registering the discharge of liquids by pumps." G. S. Hertslet, E. S. Morris and H. W. Knott. Dated October 24th, 1901.

21,433. "Improvements in electric heating apparatus." T. V. Smith and C. J. Watts. October 25th, 1901.

21,564. "Improvements in and relating to Jacquard card-punching machines." O. Zerkowitz. Dated October 26th, 1901.

21,565. "Improvements in or connected with electrical switch gear." E. T. Ruthven-Murray and Ferranti, Ltd. Dated October 26th, 1901.

21,602. "Improvements in polarised electro-magnetic devices." L. Cerebotani and C. Moradelli. Dated October 28th, 1901.

21,646. "Improvements relating to carbons for arc lamps." H. Viertel and C. Pueschel. Dated October 28th, 1901.

21,665. "Improvements in the construction and production of the terminals of electric glow-lamp sockets, and in their fitting to and insulation from the casing of the said sockets." C. Y. Hopkins. Dated October 29th, 1901.

21,701. "Improvements in and connected with ship's compasses, ship's telegraph and the like." H. Oppenheimer. (Actien Gesellschaft, Mix & Genest.) Dated October 29th, 1901.

21,715. "Improvements in electricity meters." R. S. White. Dated October 29th, 1901.

21,744 "Improvements in apparatus for the wireless transmission of electric oscillations." A. F. Collins. Dated October 29th, 1901.

21,760. "Improvements in method of and means for tandem connecting asynchronous alternating electric current motors or generators." E. Danielson. Dated October 29th. 1901.

21,762. "Improvements in or relating to suspended railway vehicles." J. Wetter. (Continentale Gesellschaft für Elektrische Unternehmungen.) Dated October 29th, 1901.

21,767. "Improvements in windings for electro-magnetic spools or coils." J. A. Heany. Dated October 29th, 1901.

21,878. "Improvements in or connected with electric time switches." E. Morgan. Dated October 30th, 1901.

21,935. "Improvements in incandescent electric lamps." J. McCullough. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, April 2nd.) Dated October 31st, 1901.

1902.

77. "Improvements in the method and means of registering the consumption of electric current or other forms of energy developing heat." E. S. Isham. Dated January 1st.

303. "Improvements in circuit closers for portable electrical apparatus." W. Roche. Dated January 4th.

360. "Improvements in contact devices for electric railways." E. P. Wetmore. Dated January 6th.

361. "Improvements in contact boxes for electric railways." W. M. Brown. Dated January 6th.

380. "Improvements in contact shoes for electric railways." W. B. Brown. Dated January 6th.

609. "Improvements in electrical switches and 'cut-outs.'" R. F. Hall. Dated January 9th.

914. "An improved electric arc lamp for light cure purposes." R. Otto. Dated January 13th.

947. "An apparatus to give alarm by means of an electric bell in the event of a locomotive running past a signal at danger." B. J. Chubb. Dated January 14th.

999. "Improvements in electrically-controlled switches." E. de Pass. (Cheatham Electric Switching Device Co.) Dated January 14th.

1,027. "Improvements in sectional conductor systems of electric railways." E. W. Farnham. Dated January 14th.

1,028. "Improvements in sectional conductor systems of electric railways." E. W. Farnham. Dated January 14th.

1,059. "Improvements in or relating to rotary fans." J. C. Fell. Dated January 14th.

1,136. "Improvements in electrodes for arc lamps." Gebr. Siemens & Co. and H. Viertel. Dated January 15th.

1,224. "An electro-magnetic engine governor." A. Schmid. Dated January 16th.

1,344. "An electric switch." G. Higginton. Dated January 17th.

1,417. "A new or improved electric meter." F. Wyatt. Dated January 18th.

1,496. "Improvements in electric switches." H. H. Berry and others. Dated January 20th.

1,548. "Improvements connected with elevators and lifts." Otis Elevator Co., Ltd. Dated January 20th.

1,675. "Improvements in or relating to sparking plugs for motors." A. J. Boult. (Dr. Pierre Martin.) Dated January 21st.

1,736. "Improvements in arrangements for controlling and regulating the supply of electricity to medical heating apparatus and the like." A. Phillips. Dated January 22nd.

1,737. "Improvements in electrically-heated sweating appliances for medical use." A. Phillips. Dated January 22nd.

1,868. "Improvements in systems of electrical distribution." B. Hopkinson. Dated January 24th.

1,984. "An improved electric transformer." W. T. Stutchbury and C. Garick. Dated January 24th.

2,084. "Improvements in joints and joint boxes for electrical conductors." G. Wilkinson. Dated January 27th.

2,159. "Improvements in and relating to electric fuses." C. Shawfield. Dated January 27th.

2,701. "Improvements in telephone line jacks." G. Lambert. Dated February 3rd.

2,774. "Improvements in electrical switches." R. F. Hall. Dated February 4th.

2,816. "Electric battery." C. A. Allison. Dated February 4th.

2,890. "Improvements in apparatus for the electrolysis of water." P. Garuti. Dated February 4th.

3,024. "Improvements relating to electric traction by the surface contact system." B. Cruvellier. Dated February 6th.

3,154. "Improvements in sockets for uniting two telegraph wires." S. Frank. Dated February 7th.

3,224. "Improvements in intercommunication telephone systems." Dr. L. Cerebotani and M. Baumer. Dated February 8th.

3,248. "Improvements in electric signal register and telephone system." P. Jensen. Dated February 8th.